FOUNDRY TRADE JOURNAL

EST. 1902

WITH WHICH IS INCORPORATED THE IRON AND STEEL TRADES JOURNAL

VOL. 110
No. 2300

JANUARY 5, 1961

Registered at the G.P.O. as a Newspaper

Offices: John Adam House, John Adam St., London, W.C.2

Single Copy, 1/-. By Post 1/4. Annual Subscription, Home 52/-, Abroad 60/- (Prepaid)

"Darwen Brand"

DARWEN TOWER

✲ Refined Cylinder and Malleable Pig Iron

✲ Special Alloy Pig Iron and Hi Carb Iron

✲ Sole manufacturers of AUTOMAT (Regd.) Pig Iron

Rehped Iron Co. (Darwen) Ltd.

Schieldrop

SELF-PROPORTIONING

OIL BURNERS

FOR

CONSTANT

AIR-OIL RATIO

By means of a simple lever operation these burners ensure an accurate control of air and oil ratio giving peak efficiency, outstanding accuracy and high product quality. Schieldrop pioneered the self-proportioning burner in Great Britain and their unrivalled experience in furnace firing is recognised by the leaders in British Industry.

Write for full details of Schieldrop Burners.

Schieldrop & COMPANY LIMITED

STOTFOLD • BEDS

TELEPHONE 414 (4 LINES)

For fine quality CASTINGS like these... SPERMOLIN core oils and binders are what you need

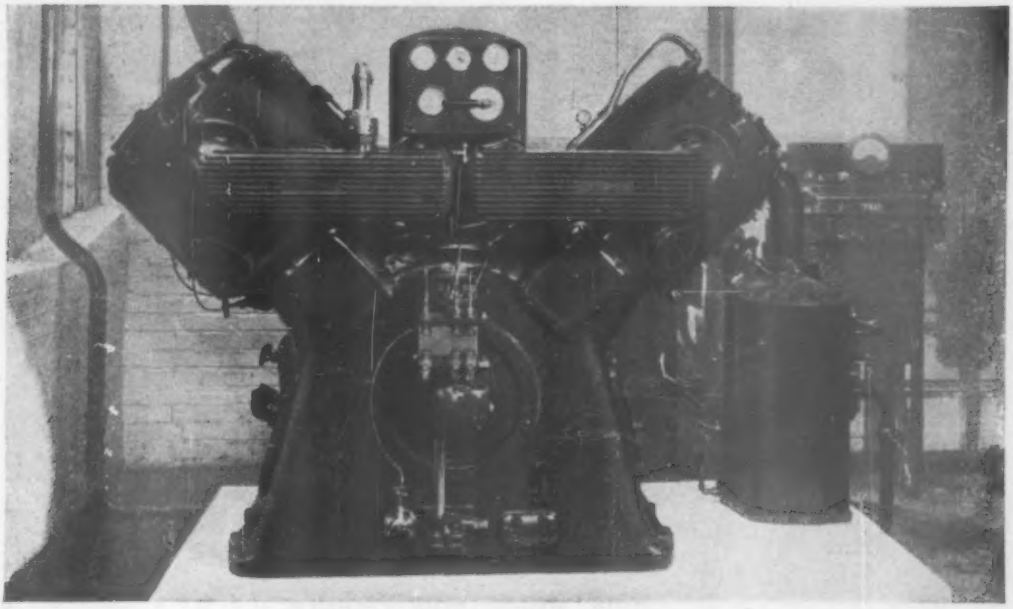

Photo by courtesy of Messrs. Broom & Wade, Ltd., High Wycombe, Bucks.

Spermolin core oils ensure the very finest quality castings. They helped produce the castings for this famous 'BROOMWADE' machine—a two-stage double acting air compressor of advanced design, Type V500, which delivers 525 cu. ft. of free air per minute at 100 lbs./□" pressure.
Direct Coupled to a 100 B.H.P Motor. Speed 485 R.P.M.

CORE OILS · COLD SETTING OILS · CORE CREAMS · SEMI SOLIDS
CO_2 BINDERS · CEREAL BINDERS · MIXING & CORE MACHINES

Spermolin
REGISTERED TRADE MARK

the secret of good casting

Established over half a century
WRITE TO: SPERMOLIN LIMITED, UNION STREET SOUTH, HALIFAX, ENGLAND. TEL: 4197

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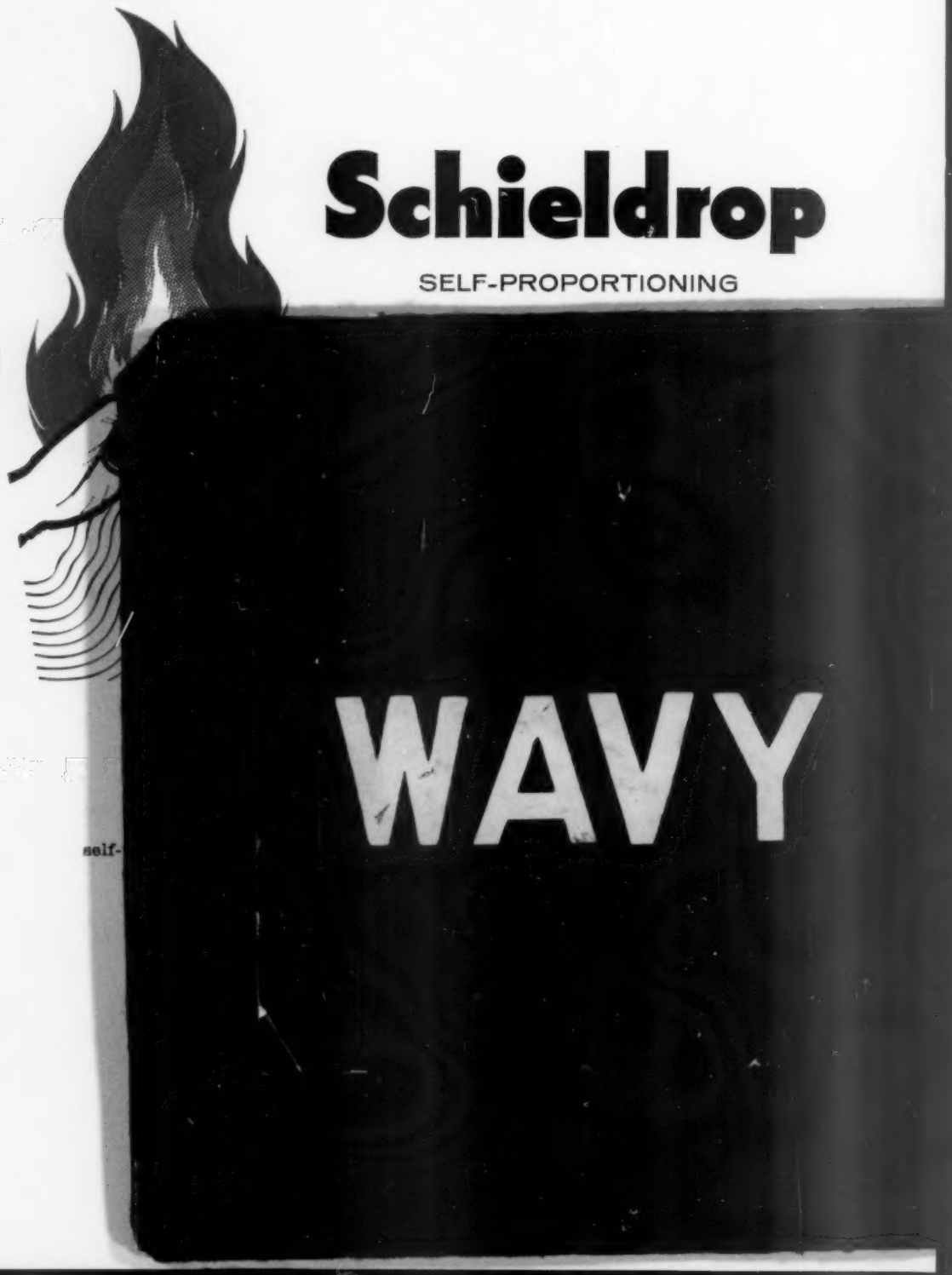
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SELF-PROPORTIONING
WAVY

For fine quality CASTINGS like these... SPERMOLIN core oils and binders are what you need

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D. TEL: 4197

A

BERKOAL keeps sand in good mouldable condition.

Ask Berk

for

BERKOAL

for foundry sands.

2%-3% BERKOAL increases green strength. Stops scabbing and expansion troubles. Reduces Coal dust.

YOU CAN TRY BERKOAL FOR NOTHING.

Just let us know how much you require to make a practical test and we will despatch gratis.

F. W. BERK & Co., Ltd.

Telephone: HUNter 6688

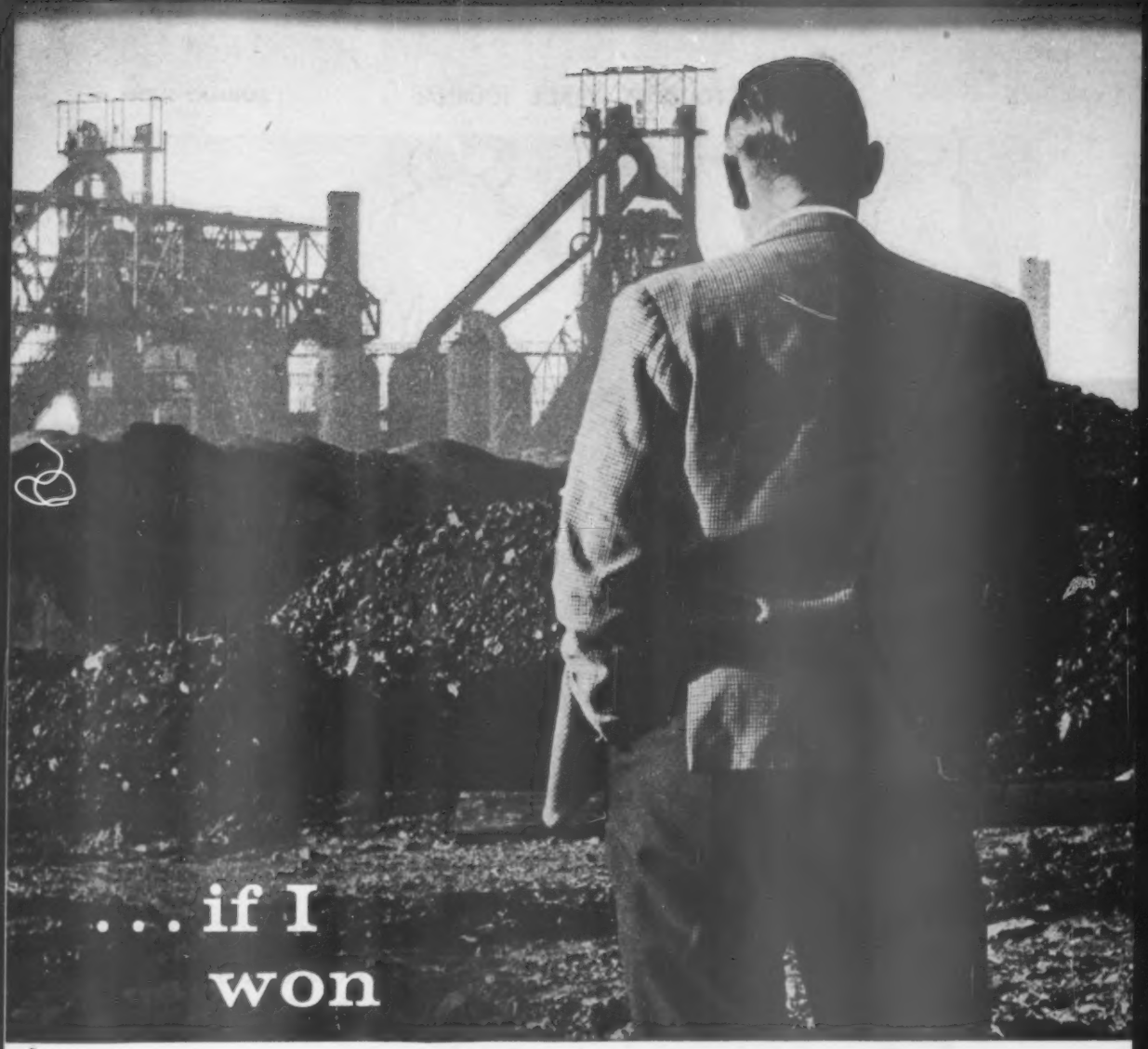
MANCHESTER GLASGOW

BELFAST SWANSEA

To F. W. BERK & Co., Ltd., P. O. Box 500,
Berk House, 8, Baker Street, London, W.1

Please send me ☐ . . . lbs. Berkoal and information leaflet.

M .....



the pools

". . . and I might at that if a couple of teams I could mention were to buy themselves some decent centre forwards.

"Football is a funny game. One week a club is a world-beater and yet a few days later they can be licked to a frazzle by a team from a girls' school.

"Heaven help us if we carried on that sort of caper at AW. Customers don't want firms that are up one minute and down the next. When buyers come to a company with our reputation they expect—and get—a reliable performance. Fancy telling them that a load of pig wasn't up to specification because one of our furnacemen was off form!

"I reckon I'd get a coupon up every week if footballers were only half as consistent as the AW team."

REFINED PIG IRON

'Supplied to any specification at short notice'

AW

ARMSTRONG WHITWORTH (METAL INDUSTRIES) LIMITED

Close Works · Gateshead Upon Tyne 8 · Telephone: Gateshead 71261

Steel Foundry: Western Road Works · Jarrow · Co. Durham.

A1

Whatever their HORSE power, engines purr like PUSSIES when their castings have been cored with Sternocore sand binders—they will go on doing this for DONKEY'S years. Sternocore products* can be equally trusted to give the same harmonious results till the COWS come home!

* *We won't bother you with the technical "gen" here, but just say the word and we will have a representative round with the milk in the morning.*

STERNOL Oils

PLEASE HELP SPASTICS

STERNOL LTD., ROYAL LONDON HOUSE
FINSBURY SQUARE, LONDON E.C.2. Telephone: MONarch 3871-5

This Pneulec plant provides all facilities from knockout through sand cleaning and mixing to delivery over moulding units. We build similar plants in all capacities.

Built in England by

PNEULEC LIMITED, SMETHWICK, Nr. BIRMINGHAM

THIS CRESCENZI FURNACE may be just what you need

It is a Mains Frequency Electric Induction Furnace of the Coreless "CSA" Type for the production of special iron and steel, reclamation of C.I. borings and recarbonisation of steel scrap. With this furnace temperatures up to 1600°C. can be obtained and continuous or intermittent operation is permissible.

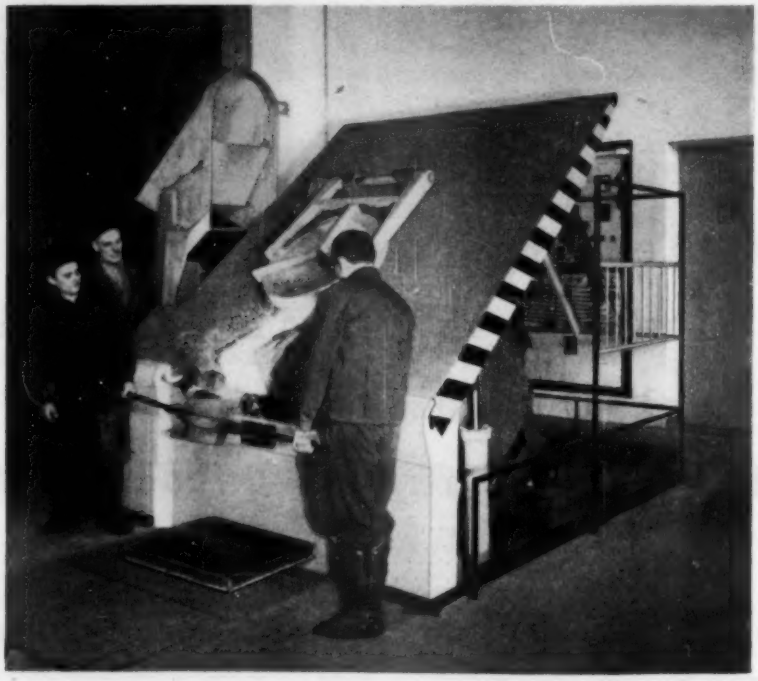
if it is

GET IN TOUCH WITH **Roper**

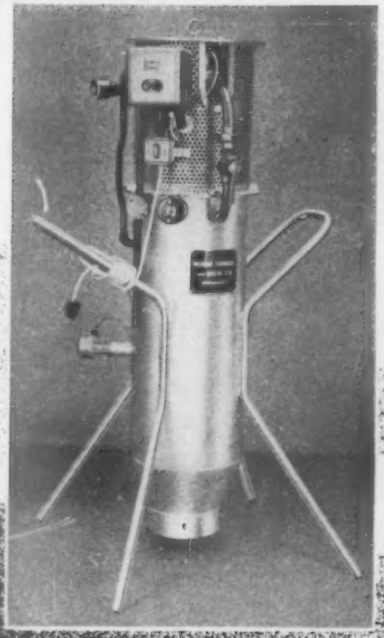
E. A. ROPER & CO. LTD. FOUNDRY EQUIPMENT ENGINEERS, KEIGHLEY, YORKSHIRE

Tel : Keighley 4215/6 *Grams : "Climax," Keighley*

The illustration shows a Coreless Furnace (Reference "CSA") of 1½ tons capacity, with a rating of 300 KVA.



An important Drying Unit



Axial Jet-M hot air unit

Developed by the North Western Gas Board under whose licence we are manufacturing it, this new Hot Air Unit is of unique design, robust construction and light weight. A cylindrical body encloses combustion chamber and ignition controls. An axial fan provides air for heating and delivery; this fan also keeps the cylinder cool when in use. The unit is self-supporting, standing on legs which are integral with the body. Push button control is included with high voltage ignition and an electronic device operates a solenoid valve in the gas supply to provide protection against electrical and gas failure.

TECHNICAL DATA

Thermal Output: 400,000 B.T.U.s per hour
Hot Air Discharge: 400 cubic feet per minute at N.T.P.

Temperature Range up to 400°C.
Weight of Unit 140 lb.

Send for fuller details. As Industrial Furnace Builders we can also supply other equipment for chemical processing including Portable Hot Air Dryer unit and Gas Burner.

MODERN FURNACES and STOVES LIMITED

Specialists in FOUNDRY DRYING EQUIPMENT

BOOTH STREET, BIRMINGHAM 21. phone: SMEthwick 1591-2 grams: Mofustolim, B'ham 21

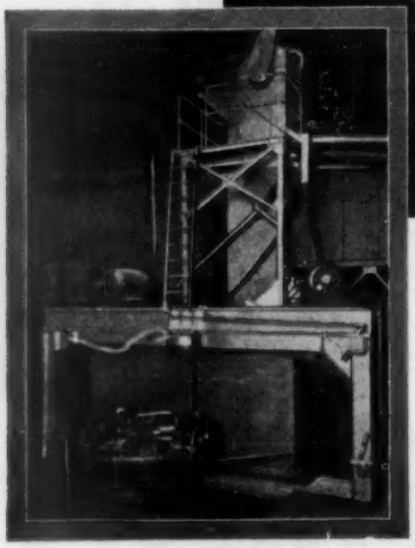
Drew Brown Limited
5410 Ferrier Street,
Montreal, 9, Canada.

COMMONWEALTH AGENTS

Forrest Engineering (PTY.) Ltd.
P.O. Box 6738
Johannesburg, South Africa

TILGHMAN'S Dual Swing Table Wheelabrator Plant

using W[illegible] Steel Shot



The plant illustrated is a 6ft. Dual Swing Table Wheelabrator installed at Messrs. Jarrow Metal Industries Ltd. It is engaged in cleaning a miscellaneous load of steel castings and the cleaning cycle is eight minutes. This type of plant enables one table to be unloaded and reloaded whilst the other table is under the blast stream and each table is capable of carrying two tons.

LESS THAN FIVE TONS OF STEEL SHOT CONSUMED IN 6 MONTHS

This plant was installed in November, 1956 and in May, 1957 had not used all of the 5 tons of S.460 WHEELABRATOR Steel Shot delivered.
In the first few weeks of operation the machine was working three shifts per day in order to catch up on production, but is now employed on a 44-hour week only. During five weeks of the early period, 250 tons of steel castings were Wheelabrated and maintenance replacements in this time amounted to one set of blades and one deflector plate.

TILGHMAN'S LIMITED · BROADHEATH · ALTRINCHAM · CHESHIRE

A member of the Staveley Coal and Iron Co. Ltd. Group.
LONDON OFFICE: 1 Chester Street S.W.1.

AGENTS: MIDLANDS.—R. J. Richardson & Sons Ltd., Commercial Street, Birmingham, 1.
SCOTLAND.—Balbardie Ltd., 227, Bath Street, Glasgow, C.2; 110, Hanover Street, Edinburgh 2.
NORTHERN IRELAND.—Stewart Industrial Services Ltd., 129, Ormeau Road, Belfast.

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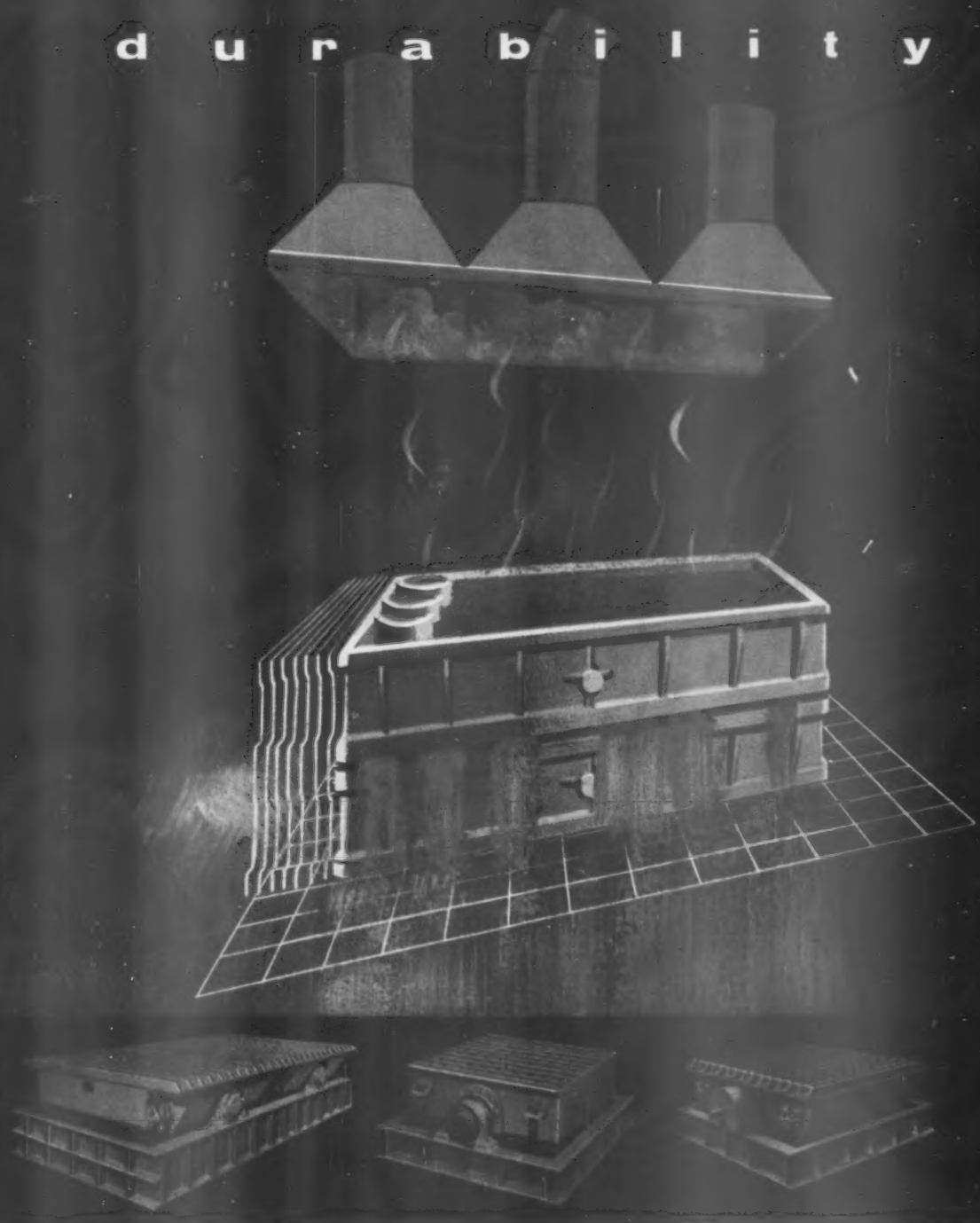
d u r a b i l i t y



Solid ribbed hot-rolled steel sections re-inforced externally enable these boxes to resist the roughest usage for the maximum period . . . prolonged if a Shakeout Machine is used.

STERLING FOUNDRY SPECIALTIES LTD., BEDFORD, ENGLAND

Sterling

Cogent
605

CAST IRON PIPES and JOINTS

MOULDING SAND and GANISTER

FOCUS ON 'FULBOND'

Nº7 'FULBOND' in semi-synthetic moulding sands

A semi-synthetic sand is generally regarded as a mixture of natural and silica sands, in varying proportions. For certain classes of work, two or more foundry sands when blended together, give much better results than would either used separately. This type of sand is a useful compromise between natural and synthetic sands and fits many foundries where synthetics cannot be used.

Semi-synthetic sand increases the flexibility of jobbing foundry practice. It should be milled frequently, however, as the inclusion of silica sand tends to dilute the strength of the natural sand. Silica sand may be added as a calculated addition, or by allowing burnt core sand to enter the system at knockout. FULBOND will restore the moulding properties as required.

The amount of FULBOND to be added will depend on:

1. The clay content and bond strength of the natural base sand.
2. The proportions of new natural sand, reclaimed moulding sand and new silica sand.
3. The requisite working moisture.
4. Milling time.

The principal advantages of a semi-synthetic sand are to increase permeability and plasticity and to reduce temper moisture.

THE USE OF 'FULBOND' IN FOUNDRIES

For a copy of this Brochure please write to:

THE FULLERS' EARTH UNION LTD

Patteson Court, Nutfield Road, Redhill, Surrey

A member of The Laporte Group

CMF62

Sixteenth century carving in the church of St. Peter and St. Paul, Drax, of pig playing bagpipes. Photograph by Ruth Meyler & F. C. Sillar

50 MILLION PIGS GO TO MARKET!

In the early days of the industrial revolution manufacturers frequently looked for familiar and easily recognisable descriptions of their products. To the countryman transplanted into industrial surroundings nothing was more familiar than a pig; a fact which is emphasised by carvings in scores of old churches depicting pigs suckling their litter, rooting for acorns and playing the bagpipes. (Apparently this last pastime was forsworn by pigs many years ago because of unpleasant associations between bagpipes and pigs bladders.) Consequently, when iron from Blast Furnaces was directed into long troughs and from there into short and narrow troughs placed at right angles, a resemblance to sows suckling their appendaged litter led to the description of 'pig iron'.

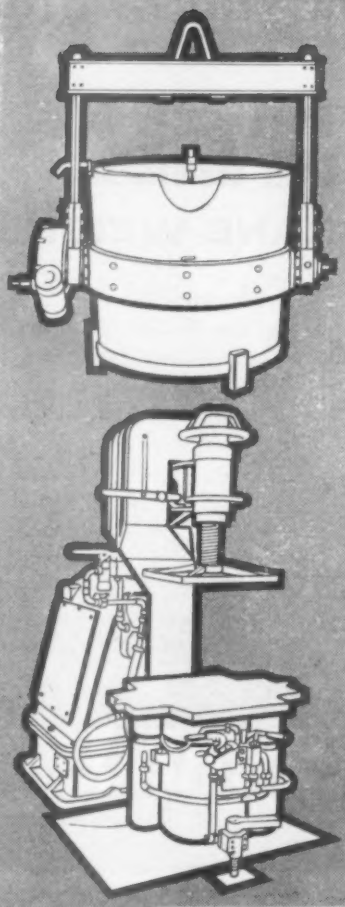
This series of advertisements illustrates some of the 'ecclesiastical' pigs and emphasises the 50,000,000 'special' pigs which Warner and Company have supplied to Iron Foundries producing High Duty Castings.

WARNER WARNER WARNER

"Pioneers of Refined Pigiron"

KA WARNER & CO. LTD., MIDDLESBROUGH

TWW FOUNDRY PLANT



The following Selection is available from stock subject to remaining unsold:

NEW VORTEC STANDARD MODEL CORE SAND MIXER: 56lb. capacity; vee belt driven from 2 H.P. Motor, 400/440/3/50 cycles supply.

FOUNDRY EQUIPMENT TYPE BM2 SAND MILL: pan dia. 6ft. 10in.; capacity approx. 4-tons batch per hour. Under-driven through vee belt drive.

COLEMAN TYPE WT.563C STOCKLESS JOLT SQUEEZE STRAIGHT DRAW MOULDING MACHINES, load 800lb.; pattern draw 12in.; size of table 35in. by 24in.

NEW GUYSON SHOT BLAST CABINET, size 42in. by 30in. by 36in.; complete with dust collector and extraction unit wound for 400/440/3/50 cycles supply.

MORRIS TYPE 'M' SCREENERATOR, motorised for 400/3/50 cycles supply.

COLEMAN WALLWORK TYPE CN JOLT SQUEEZE RAM PATTERN DRAW MOULDING MACHINE, load 600lb.; pattern draw 10in.; suitable for boxes 20in. by 20in. or 25in. by 12in.

WALLWORK SHOCKLESS JOLT SQUEEZE TURNOVER DRAW MOULDING MACHINE, load 300lb.; pattern draw 9½in.; table 22½in. by 17½in.

CLIMAX 80E STATIONARY AIR COMPRESSOR, 320 CFM. 100 p.s.i., with 90 H.P. Brook motor and starter.

SHOT BLAST PLANT: RUMBLING BARRELS FURNACES : AIR COMPRESSORS AVAILABLE FROM STOCK.

THOS. W. WARD LTD

ALBION WORKS · SHEFFIELD · Phone 26311

LONDON OFFICE: BRETTENHAM HOUSE · STRAND · W.C.2

PP19

FOR INCREASED PRODUCTIVITY
IN THE FOUNDRY –

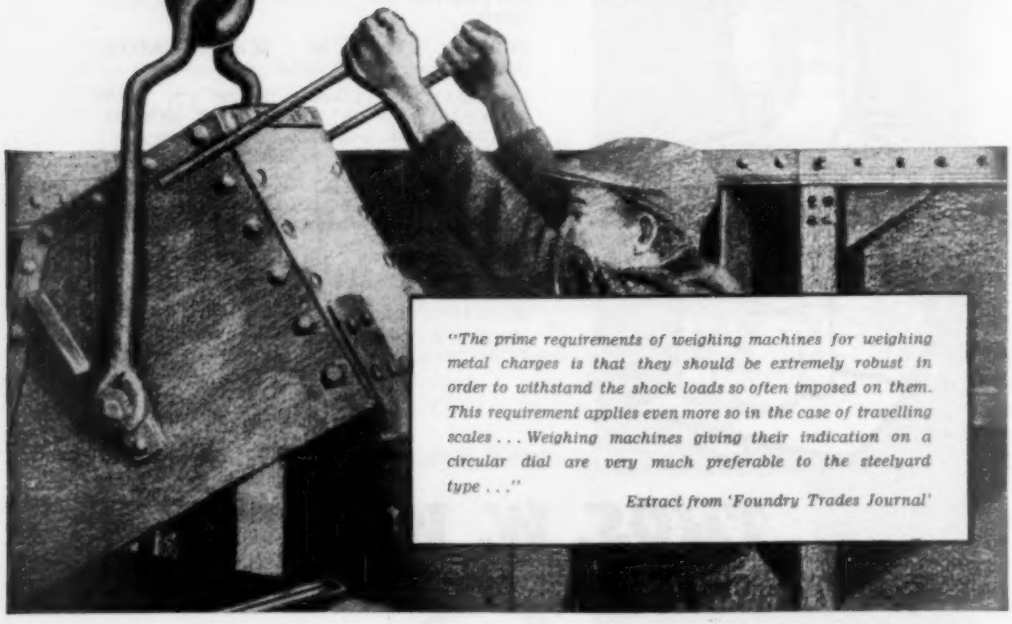
Weigh as you charge

WITH THE

SALTER

No. 99 CRANE WEIGHER

When it's a big, tough weighing job such as weighing metal charges, the Salter '99' saves time and labour and speeds production. Accurate weight at a glance. Listed in capacities from ½ to 100 tons, larger capacities to special order.



"The prime requirements of weighing machines for weighing metal charges is that they should be extremely robust in order to withstand the shock loads so often imposed on them. This requirement applies even more so in the case of travelling scales . . . Weighing machines giving their indication on a circular dial are very much preferable to the steelyard type . . ."

Extract from 'Foundry Trades Journal'

GEO. SALTER & CO. LTD., WEST BROMWICH

H-W.405

THE NEW BULK MELTER – MORGANS 1300 BASIN TILTER

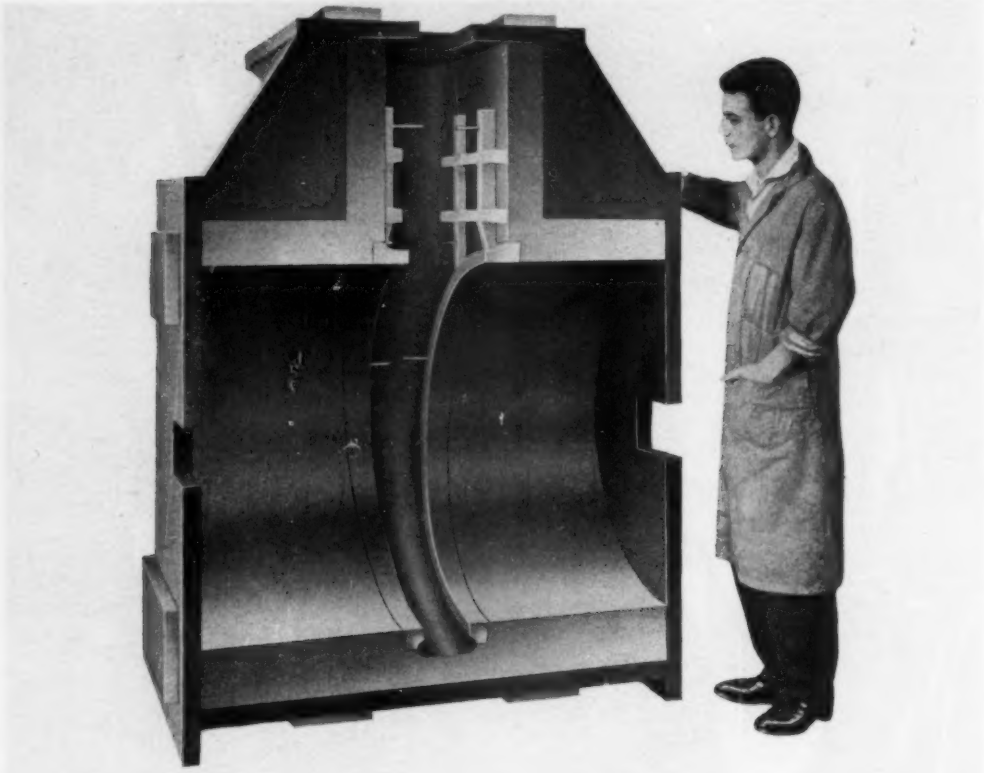
1300 lb of Aluminium in the hour! Come and see it at the Battersea Test Foundry or ask our Representative to call.

MORGANS

THE CRUCIBLE DEPARTMENT

THE MORGAN CRUCIBLE COMPANY LIMITED,
NORTON WORKS, WOODBURY LANE, NORTON, WORCESTER.
Telephone: Worcester 26691. Telegrams: Crucible, Worcester.

F53A



For man-size jobs

Crockett Lowe Ltd of Birmingham made this large corebox of Araldite epoxy casting resin. It provides an exact replica of the original, at a fraction of the cost of a duplicate pattern in wood and in a very short space of time. Araldite hardens at room temperatures without shrinkage, so that no dimensional allowances are necessary. The product is tough, not easily damaged, is unaffected by damp or changes of temperature, and needs no particular care in storage. Furthermore, modifications can be made economically if required, using the same Araldite mixture of resin, hardener and filler.
May we send you information on the use of Araldite in foundries?

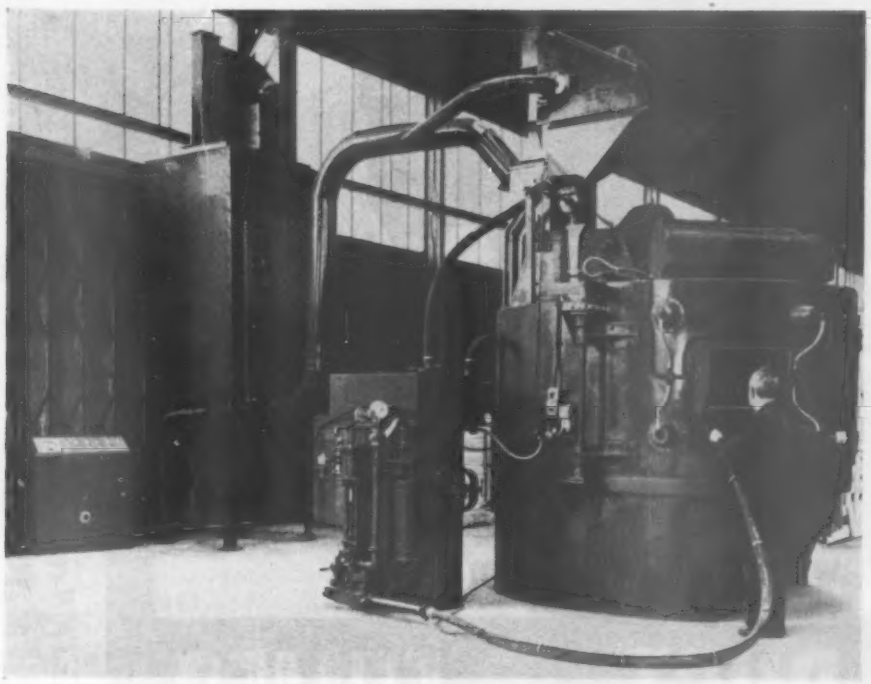
Araldite **epoxy casting resins**

Araldite is a registered trade name

CIBA (A.R.L.) LTD, Duxford, Cambridge. Telephone: Sawston 2121
APS4

HEPBURN CONVEYOR Co. Ltd.

— WAKEFIELD —



6' 0" dia. 'LK' Table Shot Blast Machine complete with Touch-up Unit together with Dust Collector.

Panqborn

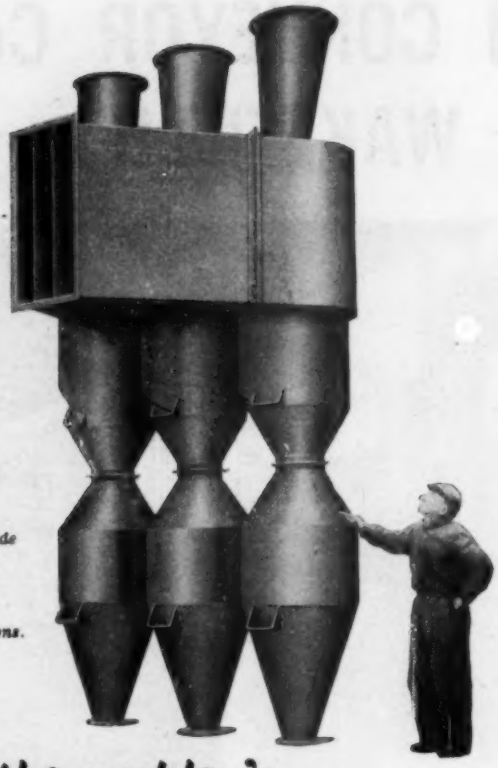
SHOT BLAST & DUST CONTROL EQUIPMENT

ALSO

VIBRATORY FINISHING MACHINES

Telegrams "CONVEYOR"

Tel Nos 3695, 6 & 7



Tornado-Cyclogal centrifugal settlers provide extremely low resistance to airflow and high collection efficiency of particles down to 5 microns.

when the problem's

DUST OR FUMES

turn to 'Tornado'

For over 60 years, Industry has turned to 'Tornado' to settle dust and fume extraction problems. Keith Blackman were the first in the country to use air extraction as the basis for dust and fume exhaust systems. With this record and this experience they are the natural choice for your problem. You too, should 'turn to Tornado' for advice on *complete plants* or individual equipment. There is a qualified representative in every industrial area.

Keith Blackman Ltd

Dust and Fume Control Division

MILL MEAD ROAD, LONDON N17 TOTTENHAM 4522 TA 3691/1063

CLOTH FILTRATION

Tornado-Fischer patented, self-cleaning filters

Type 270/540 pocket filters

Series TF dust collectors

Series T self-contained dust collectors

WET FILTRATION

Solivore patented wet scrubbers

Hydro precipitator wet washers

CENTRIFUGAL FILTRATION

Cyclogal high efficiency, low resistance cyclones

Cyclogalax 'straight through' cyclones

Standard cyclones

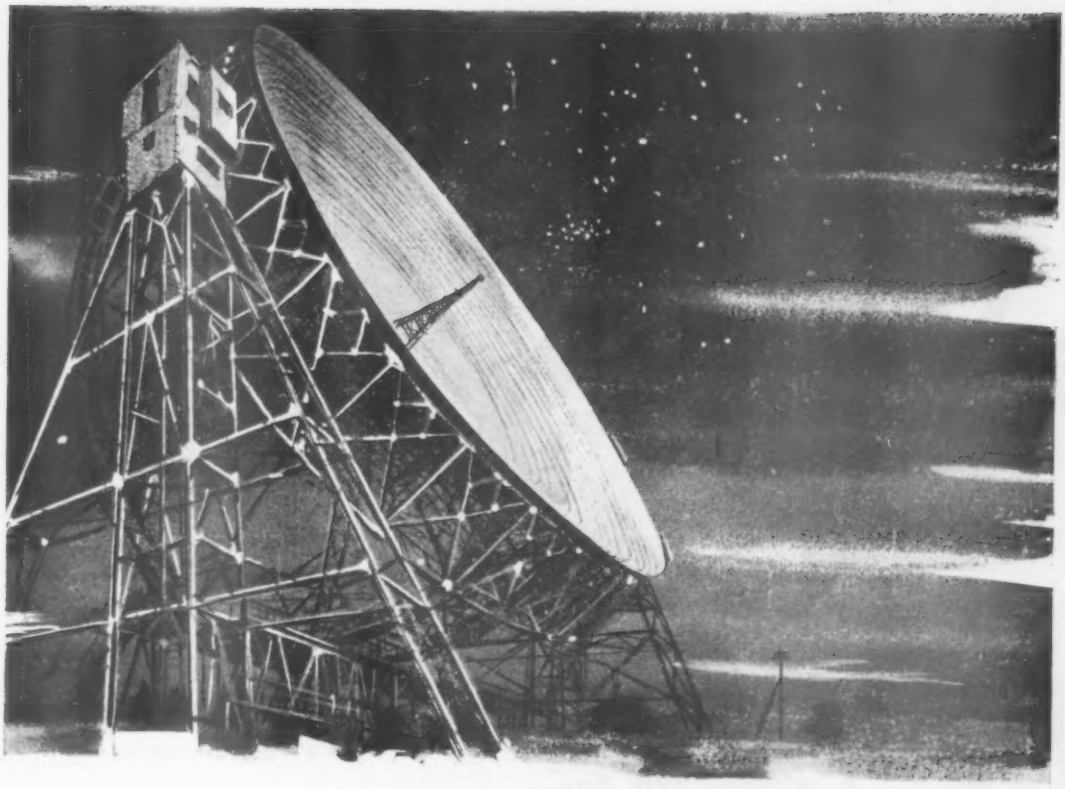
PD-KB tubular collectors

ELECTROSTATIC PRECIPITATION

PD-KB electro-static precipitators

FANS

Paddle type industrial fans



Precision

The sky's the limit at Jodrell Bank, and though we at Park & Paterson are not concerned with star tracking, that is the only limit to our service and the precision of our products.

If you're in the market for non-ferrous ingots to British Standard Specification or special analysis, may we suggest a call to Park & Paterson?

Park and Paterson Ltd.

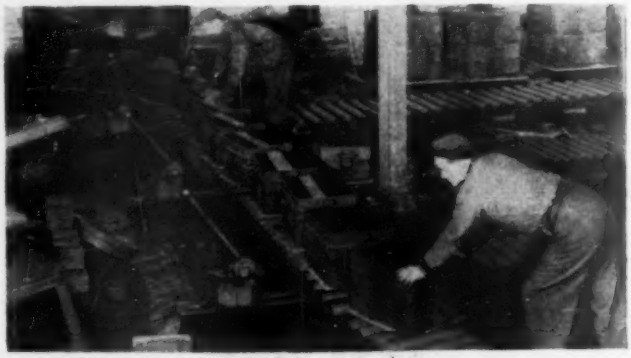
INGOT MANUFACTURERS

MANCHESTER:
MARPLE, STOCKPORT, CHESHIRE. Telephone: MARPLE 1422-3

GLASGOW:
PARKHEAD, GLASGOW, E.1. Telephone: BRIDGETON 4451-2

If you want the flexible approach to conveying

ring Rownson—Gulliver 7721

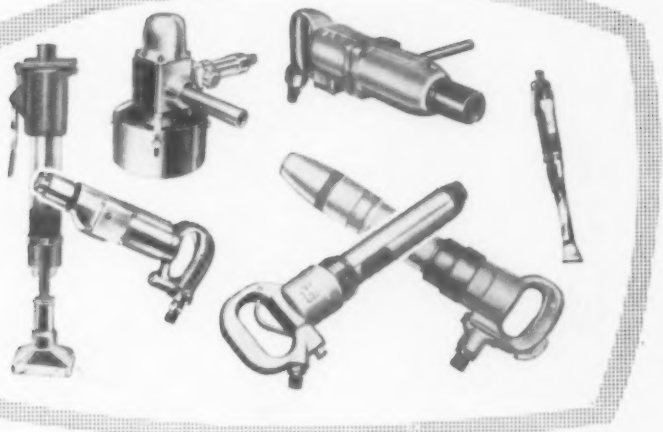


The types of conveyor Rownson supply are almost as diverse as the materials and goods they move so easily from one place to another. If you have a conveying problem that needs a flexible approach and a liveliness of outlook backed by diverse experience . . .

. . . let Rownson run the rule over it

A MEMBER OF THE BAKER PERKINS GROUP

ROWNSON CONVEYORS LTD., Maiden Lane, York Way, London, N.7. Telephone: Gulliver 7721 Cables: Conveying, London



Does air power it?

Then Holman make it

Now what's the best tool for *this* job, you ask. Pneumatic? Yes. Holman? Undoubtedly. Ah, but do Holman *make* it?

They do. Holman make pneumatic equipment for every project. There's hardly a job-need anywhere they don't know about—and deal with. Mining, shipping, construction—wherever tough, fast-working tools can get down to the job and cut down the costs.

Take your choice—from the widest range of air compressors and pneumatic tools in the Commonwealth.

The most reliable in the world.

Write now for Catalogue 44/G.P.1

Air... compressed air... **power**... Holman

Holman Bros. Limited, Camborne, England; Camborne 2275 and 44 Brook Street, London W.1: Hyde Park 9444. Also in Birmingham · Cardiff · Glasgow · Peterborough · Sheffield. Australia · Canada · East Africa · France India · South Africa · Spain · U.S.A. · West Africa. With Agents and Representatives throughout the world.

HM16

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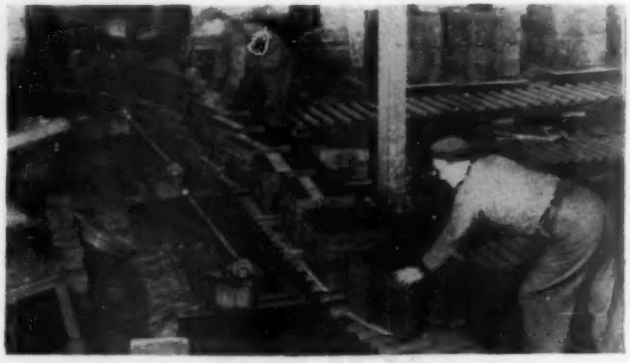
If you want the flexible approach to conveying

ring Rownson—Gulliver 7721



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. . . let Rownson run the rule over it

A MEMBER OF THE BAKER PERKINS GROUP

ROWNSON CONVEYORS LTD., Malden Lane, York Way, London, N.7. Telephone: Gulliver 7721 Cables: Conveying, London

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Also in Birmingham · Cardiff · Glasgow · Peterborough · Sheffield. Australia · Canada · East Africa · France
India · South Africa · Spain · U.S.A. · West Africa. With Agents and Representatives throughout the world.

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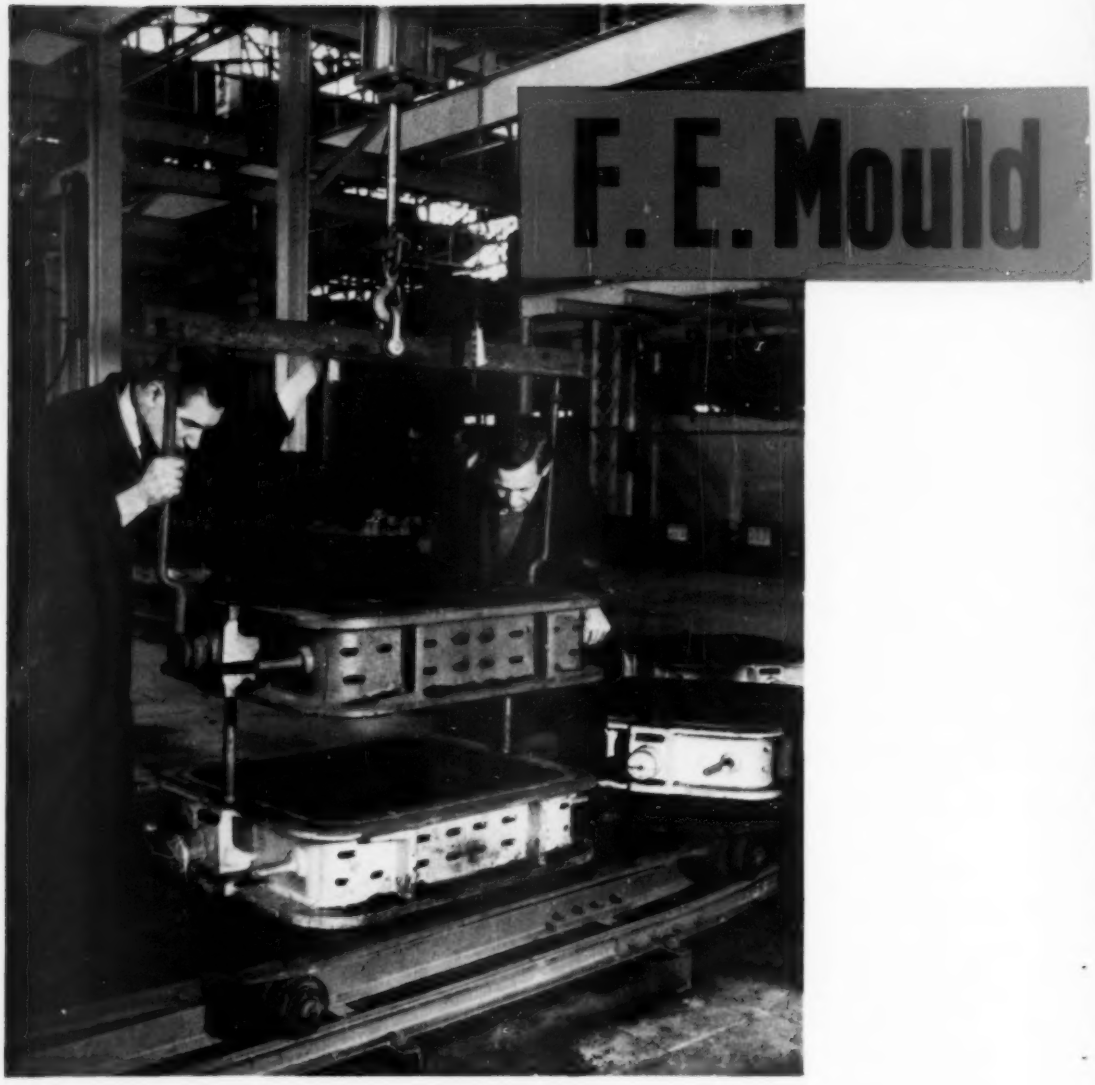

Closing a large mould is easiest on an F.E. Platform Conveyor—the only Mould Conveyor which is truly jerk and judder free. We illustrate one of the two long Conveyors (each 73 plates 2' 6" wide × 5' 0" long) recently supplied to a large automobile castings foundry in Australia. The complete installation was supplied by us.

OVERSEAS COMPANIES:

FOUNDRY EQUIPMENT (AUSTRALIA) PTY. LTD., ELIZABETH, S. AUSTRALIA
F. E. (NORTH AMERICA) LTD., TORONTO, CANADA
F. E. (SOUTH AFRICA) (PTY.) LTD., JOHANNESBURG, S. AFRICA
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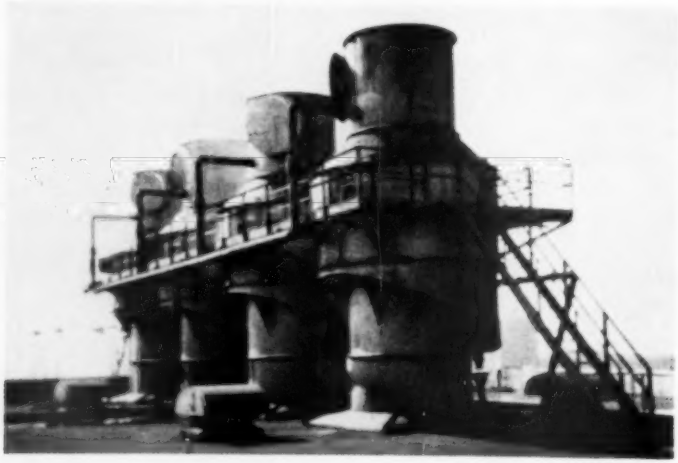

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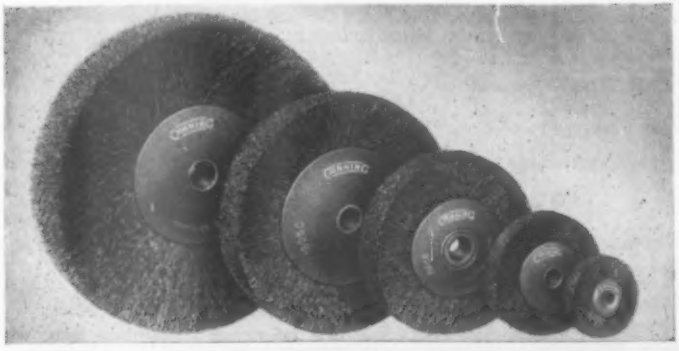

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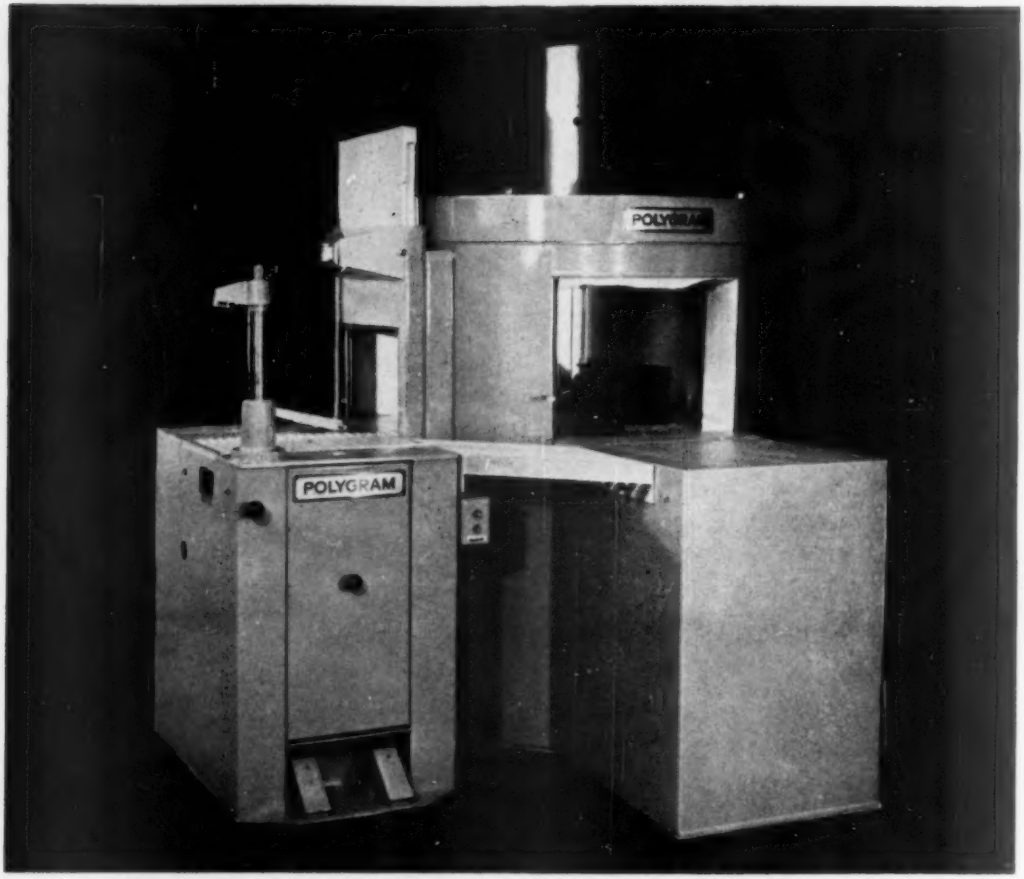

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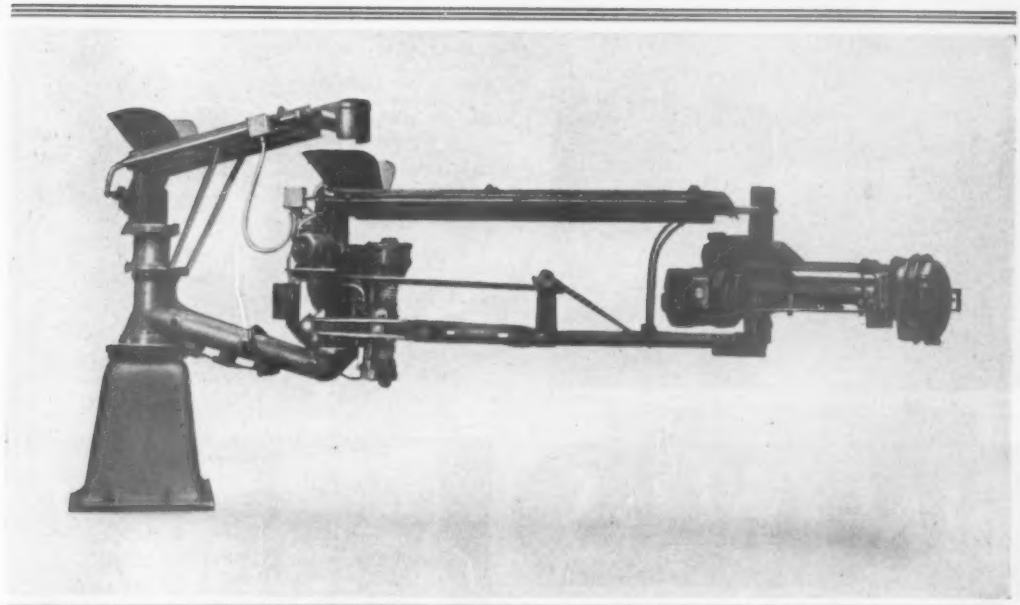

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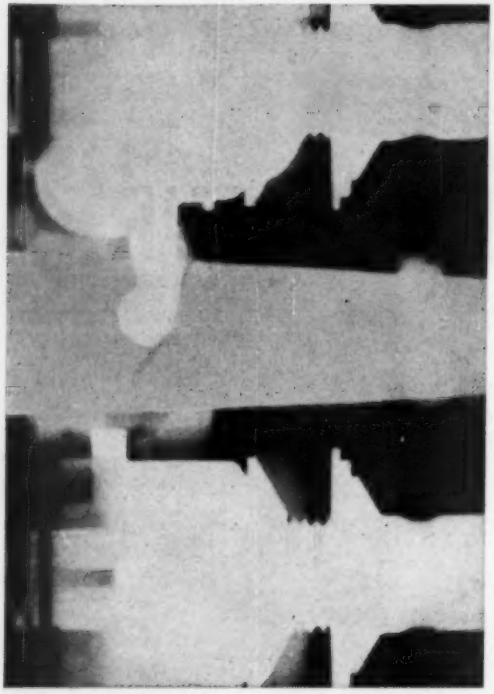

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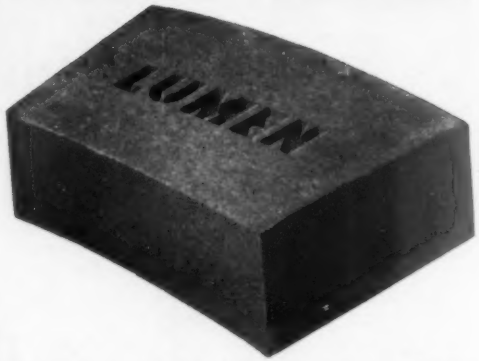

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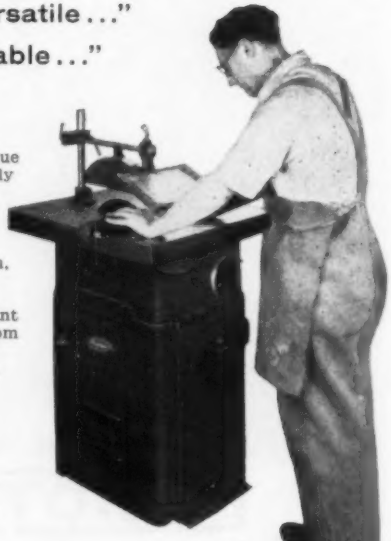

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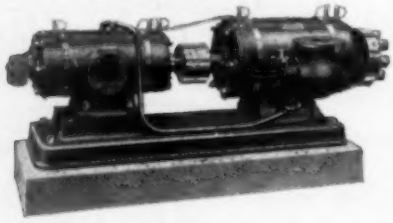

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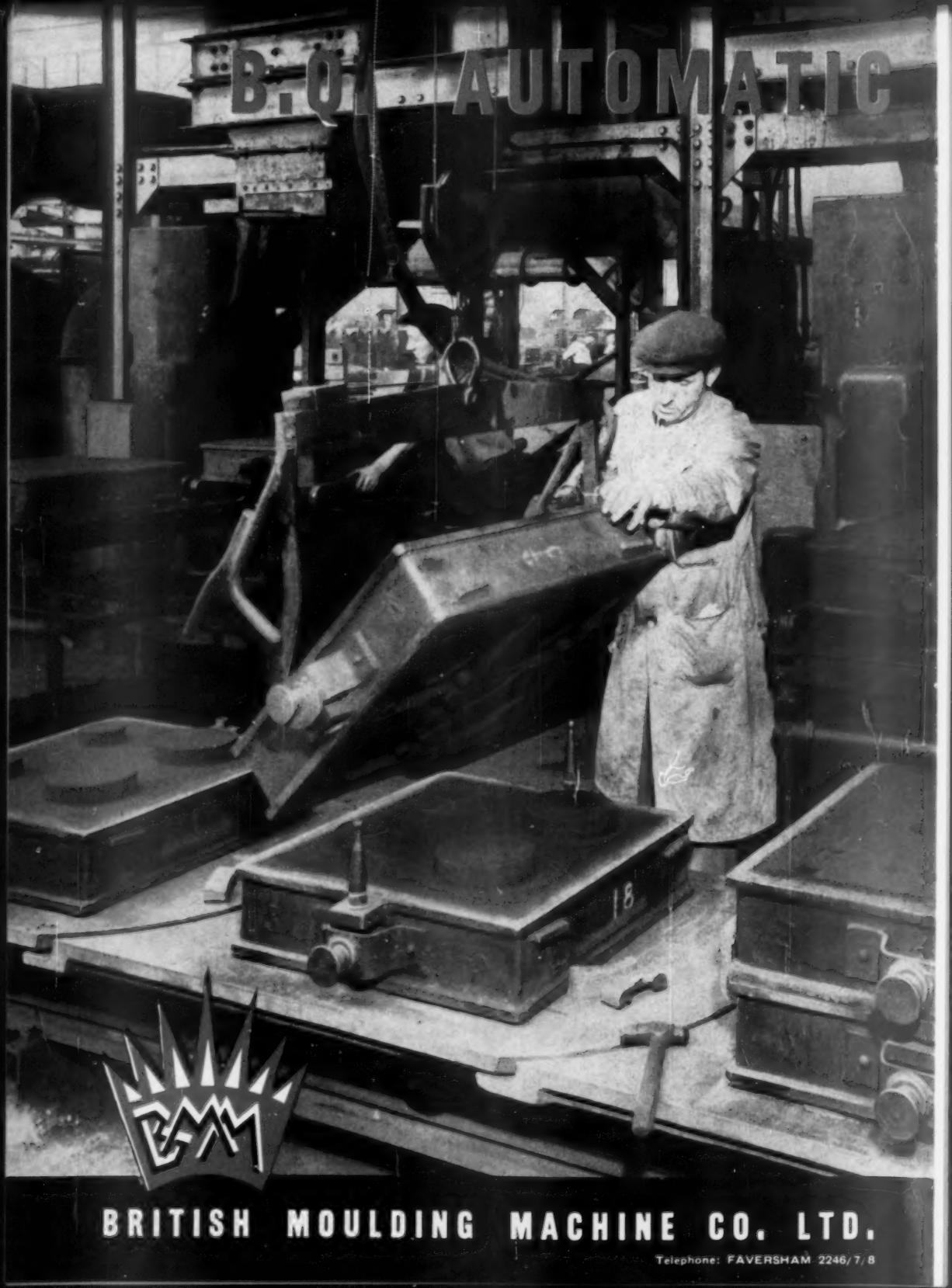
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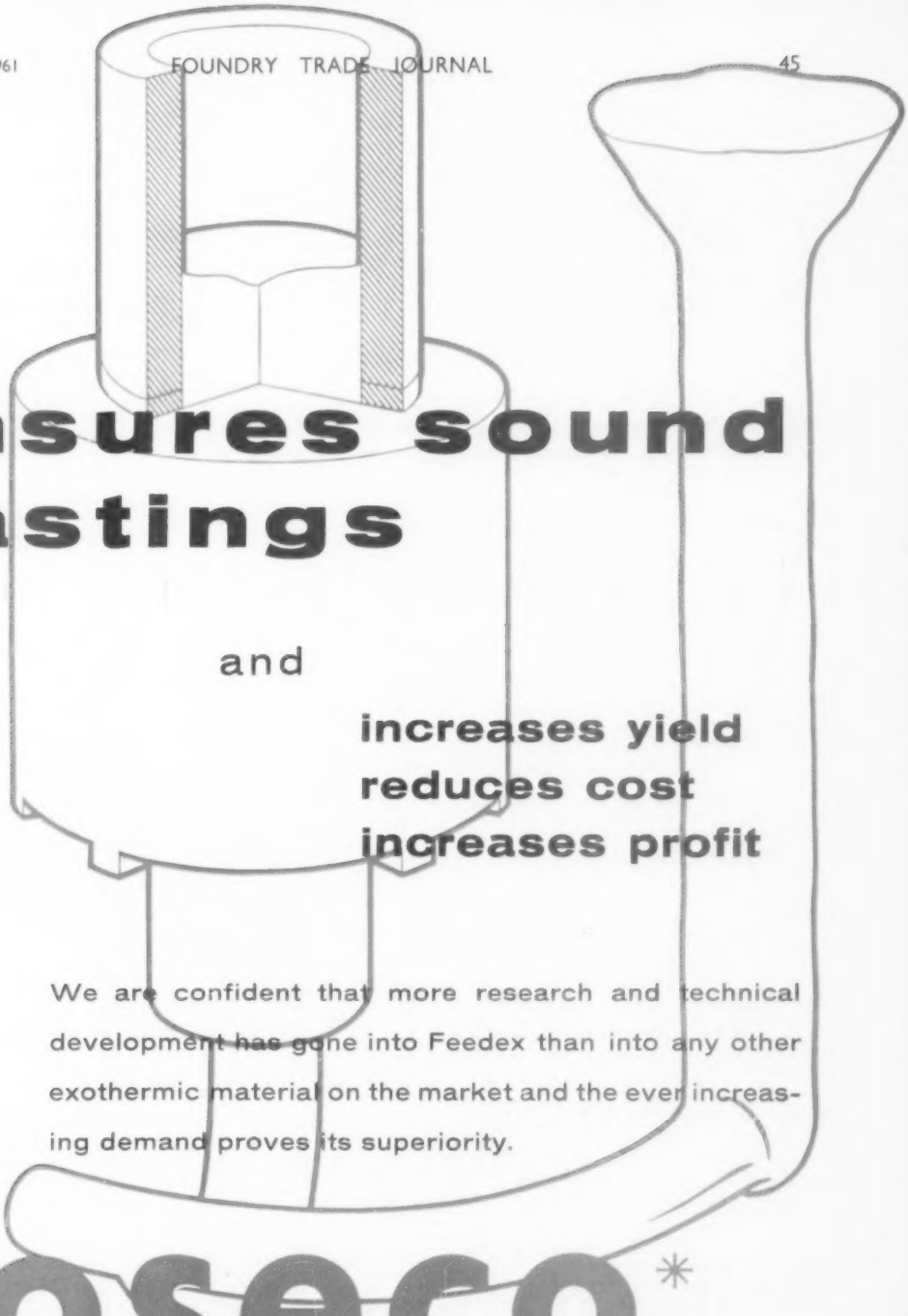

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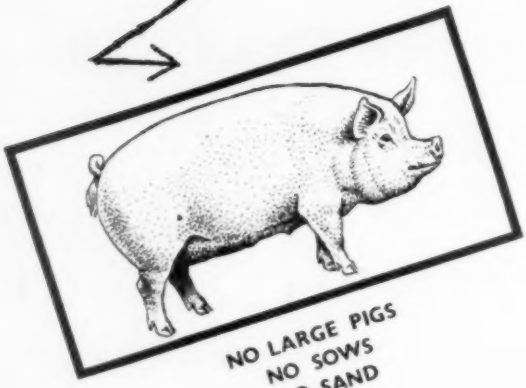

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PRINCIPAL CONTENTS

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Technical Control of Welding in the Steel Foundry

By M. G. Hipkins, B.Sc., A.I.M.

Welding is now accepted as a legitimate process for the rectification of steel castings and the assembly of relatively simple castings into complicated assemblies (cast/weld constructions). This article applies the same degree of control to steelfoundry welding as is accorded to other branches of process supervision in the foundry 3

Fixing of Brackets on Patterns

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Employer's Liability for Latent Dangers in Tools supplied to Employee

By "Barrister-at-Law" 11

BICTA Annual Conference

Being the third and fourth sessions of the discussions on papers presented at the second annual conference of the British Investment Casters' Technical Association and concluding the report made in the December 1, 1960, issue of the JOURNAL 15

Contrôle technique de la soudure dans la fonderie d'acier. Par M. G. Hipkins, B.Sc., A.I.M.
La soudure est maintenant accepté comme un procédé légitimé pour la rectification de moulages d'acier et pour l'assemblage de moulages relativement simples en ensembles compliqués (constructions moulées-soudies).
Cet article applique le même degré de contrôle à la soudure dans la fonderie d'acier, qu'aux autres branches de la surveillance des procédés utilisés en fonderie. 3

Responsabilité de l'employeur dans le cas de blessure possible occasionnée aux ouvriers par l'emploi d'outils qui leur sont fournis. Par "Barrister-at-Law." 11

Conférence annuelle de la British Investment Casters' Technical Association.
Troisième et quatrième sessions de la discussion des mémoires présentés à la seconde conférence annuelle de l'Association britannique des fondeurs à modèles perdus, et conclusion du rapport fait dans le numéro du 1er décembre du "Foundry Trade Journal". 15

Technische Überwachung des Schweissens in der Stahlgiesserei. Von M. G. Hipkins, B.Sc., A.I.M.
Schweissung ist jetzt allgemein anerkannt als ein gerechtfertigtes Verfahren zur Ausbesserung von Stahlguss und für den Zusammenbau verhältnismässig einfacher Gussteile zu verwickelten Gebilden (Giess-Schweisskonstruktionen).
Dieser Artikel befürwortet, für das Schweissen in der Stahlgiesserei das gleiche Ausmass von Kontrolle anzuwenden, wie es auf anderen Gebieten der Verfahrensüberwachung in der Giesserei üblich ist. 3

Die Verantwortung des Unternehmers für verborgene Gefahren in Werkzeugen, welche dem Angestellten übergeben wurden. Von "Barrister-at-Law." 11

Jahrestagung der British Investment Casters' Technical Association.
Dieser Bericht umfässt die dritte und vierte Diskussionssitzung über Vorträge welche auf der 2.Jahrestagung der technischen Vereinigung englischer Feingiesser gehalten wurden und beschliesst die Ausführungen im Foundry Trade Journal vom 1.Dezember 1960. 15

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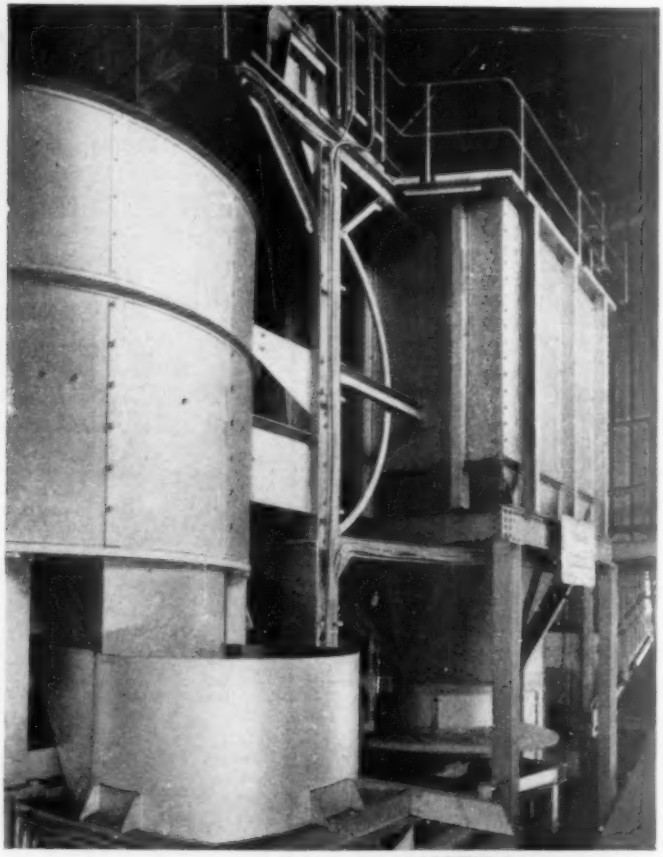

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FOUNDRY
TRADE JOURNAL

Vol. 110 January 5, 1961 No. 2300

Thoughts on Exports

Mr. Frank A. Hurst, chairman of Samuel Osborn & Company, Limited, well expressed the feelings of many foundry owners when he addressed the annual shareholders' meeting of his group of companies. He was referring to what he called unfair criticism by members of the Government and others, suggesting that generally speaking, managements and sales executives of some companies neglect export trading and have " lack of vision." In the case of Osborn's, no fewer than 21 overseas countries had been visited during the year. Instead of direct exports, more frequently it was better business, he said, for founders to supply castings to home machinery and equipment builders, who, in turn, exported finished goods and plant to bring in much foreign currency. An outstanding example which comes to the writer's mind is that it is preferable to export razor-blades rather than steel strip for their manufacture.

Well remembered is an earlier exhortation by a Minister of the Crown that directors themselves should go abroad and sell. In one case the challenge was taken up by a firm and nearly the whole directorate—five in all—decided to cover the five continents. Trade was bad and the results of their voyaging were poor. If they had stayed at home, their travelling expenses would at least have gone some way towards the firm's paying a modest dividend. For many businesses, especially the smaller ones, foreign sales missions by directors are too much of a gamble to undertake lightly.

Mr. Hurst also pointed out the banal effect of the decrying by politicians of the efforts being made by British executives and industry as a whole. First, there was the impact on the working staff of a concern, who might be given the impression that the firm's management was inefficient. Second, there should be borne in mind the reprinting of such expressions of opinion in the foreign Press, resulting in the readers losing faith in the ability of the British to give service and to supply high-quality goods. Fortunately, at this same time we read of an opinion expressed by an American to his countrymen that the increase in imports into their country was not so much on lower price but because of better design and quality. Remarks such as this to some extent neutralize depreciatory comment by some British politicians, and help to re-establish the worth of British products in the export market. As a rule persons in high office who may feel called upon to make statements about industry should accept the dictum that what is true about one section is almost certain to be untrue of another; such is the nature of things. They ought then to confine themselves to comment on subjects of which they know the parameters. There are cases when silence may indeed be golden!

Forthcoming Events

JANUARY 9

Institution of Production Engineers

Sheffield graduate section: "Grinding Wheels and their Application," by C. Perrett, 6.30 p.m., at the BISRA Lecture Theatre, Hoyle Street, Sheffield.

Institute of British Foundrymen

Sheffield branch: "Pattern Equipment for Shell Moulding," by E. C. Rowen, 7 p.m., in the Technical College, Pond Street, Sheffield.

JANUARY 10

Institute of British Foundrymen

Slough section: "Coremaking — Modern Methods and Machinery": a "Brains Trust" with J. Fallows, J. Harvey and R. Sutcliffe serving on the panel, 7.30 p.m., in the Lecture Theatre, High Duty Alloys, Limited, Slough.

Stoke-on-Trent section: "My Hungarian Tour," by Mr. A. R. Parkes, 7.30 p.m., at the Stipendiary Court Room, Hanley Town Hall.

JANUARY 11

Manchester Metallurgical Society

"Modern Methods of Metallurgical Analysis," by K. M. Bills, 6.30 p.m., at the Manchester Literary and Philosophical Society, George Street, Manchester.

Institution of Production Engineers

Liverpool section: "Recent Developments in the Soviet Union," by Dr. D. F. Galloway, 7.30 p.m., at the Liverpool International Library, William Brown Street.

Institute of British Foundrymen

Southampton section: Technical film show: "The Making, Structure, Heat-treatment and Properties of Steel," 7.30 p.m., at the Technical College, St. Mary's Street.

West Riding of Yorkshire branch: "Co-operation and Co-ordination between Patternshop and Foundry," by E. H. Beech and N. Bradshaw, 7.30 p.m., at the Bradford Institute of Technology.

Combustion Engineering Association

Discussion on the "Choice of Oil-burning Equipment," 10.0 for 10.30 a.m., and at 2 p.m., discussion on "Prevention of Acidic-smut Emission." Meeting to be held at the Royal British Hotel, 20, Princes Street, Edinburgh.

JANUARY 12

Institution of Plant Engineers

Glasgow branch: "Factory Construction from the Planning Aspect," by W. Underwood, 7.15 p.m., at the Scottish Building Centre, 425, Sauchiehall Street.

Institute of Metals

"Metallurgical Research at High Pressures," by Dr. J. E. Hilliard, 6.30 p.m., at 17, Belgrave Square, London, S.W.1.

Institution of Production Engineers

North-east branch: "Fire Prevention in Factories," by a fire prevention officer, 7 p.m., at Roadway House, Oxford Street, Newcastle-upon-Tyne.

Institute of British Foundrymen

Beds. & Herts. section: Film evening. Details from secretary.

JANUARY 13

Institute of British Foundrymen

Bristol & West of England branch: "Production of Aluminium-alloy Castings," by P. M. Slingsby, 7.30 p.m., at the Royal Hotel, Bristol.

Tees-side branch: "Problems in the Calculation of Feeding-head Dimensions," by N. Snelson, 7.30 p.m., at the Teesdale Hall, Head Wrightson & Company, Limited, Thornaby-on-Tees.

Institute of British Foundrymen

Newcastle and district branch: "High-duty Iron Castings," by D. Crooks, 6 p.m., at the Rutherford College of Technology, Northumberland Road.

Scottish branch: "Brains Trust," 3 p.m., at the Royal College of Science and Technology, George Street, Glasgow.

West Riding of Yorkshire branch: Dinner/dance, 6.30 for 7 p.m., at the Midland Hotel, Bradford.

Latest Foundry Statistics

Ironfounding: The Council of Ironfoundry Associations states that the census of employment taken on October 29, 1960, showed that 131,132 were at work in iron foundries in the United Kingdom on that day. It is 171 fewer than on October 1, 1960, but 5,531 more than a year earlier.

Mr. E. V. SMALL has been elected to the board of Blaw Knox, Limited.

Patternmaker M.P. revisits A.E.I.

The photograph shows, on the extreme right, Mr. E. Smith, MP for Stoke-on-Trent south, on his recent visit to the Trafford Park works of Associated Electrical Industries Limited. Mr. Smith returned to his bench in the patternshop to hand over to some of his former colleagues the tool chest he left there 25 years ago, when he was elected to Parliament. The chest and tools, still in excellent condition, are being sold among the apprentices and the proceeds will be donated to the Works Benevolent Fund. Mr. Smith worked in the patternshop from 1911 to 1935. Grouped with Mr. Smith are Mr. E. H. Beech, superintendent of the iron foundry and patternshop, Mr. G. Symes, foreman, G. Caldwall and S. Miller, patternmakers, Mr. A. MacDonald, shop steward, and Mr. N. Bradshaw, assistant superintendent.

Technical Control of Welding in the Steel Foundry*

By M. G. Hipkins, B.Sc., A.I.M.

Despite notable advancement in recent years, the foundry industry is not yet able to produce large and complicated steel castings which are always free of defects, and for this reason, welding is accepted as having an important part to play in the manufacture of such castings. In sections of this paper, the various stages in carrying out a welding repair or cast/weld fabrication are discussed, and notes are included on the various welding processes available.

Today, more than ever before, engineers and designers are demanding industrial materials of improved quality and increased strength. In order to meet these demands, the casting industry has realized that greater emphasis has to be placed on rigid technical-control, not only in melting procedures, but also during all the associated operations which have to be undertaken before the casting is finally despatched to the customer. Unfortunately, modern foundry practice, despite great technical advances, is not yet able to produce large and complicated steel castings which are always defect free. Defects, such as shrinkage, cracks or cavities, porosity, and areas of severe segregation, are always liable to occur and, for many years, the accepted method of rectifying such defects has been by welding.

It has been said, with some degree of truth, that the success of the foundry art is indicated by the amount of welding which is carried out and, for this reason, some foundrymen are of the opinion that the less said about welding the better. However, the number of foundrymen taking this view today is rapidly decreasing, and welding is accepted as having an extremely important part to play in the manufacture of top-quality steel castings. To play its full part, welding must be carried out under strict technical control and modern welding techniques must be used. Indeed many of the larger foundries, particularly in the United States, now consider welding as a separate department and no longer use any odd corner of the foundry in which to undertake the welding operation.

Applications of Welding

The rôle of welding is two-fold; first, for the repair of defects occurring during the manufacture of the castings, and, second, in the fabrication of composite structures. Undoubtedly, more welding is carried out to rectify defects than in fabricating composite structures, although the advent of electroslag welding has paved the way for startling developments in the field of casting fabrications. In the USSR composite fabrications exceeding a gross weight of 250 tons are being undertaken, and the advantages of such a practice will be obvious.

Irrespective of the use to which welding is to be put, the final product will be only of satisfactory quality provided that the foundry is aware of the need for rigid technical control over whichever welding process is employed. It is not sufficient merely to have competent welders, although this is, of course, a necessity. Success in welding will be obtained only if the art is thoroughly understood and controlled by the management, as there are many technical decisions to be made, particularly when the casting is of complicated form or in a special alloy.

In the following sections, the various stages in carrying out a welding repair or fabrication are discussed, together with the available welding processes.

Training of Welding Operators

The extent of the technical control applied will depend on the experience of the welder. It must be assumed that he is capable of first-class work and, accordingly, that instruction in the techniques of depositing weld metal is not necessary. However, it is essential that he should be made to realize the important rôle of welding in the production of a satisfactory casting; that he is not there as a "necessary evil" merely to cover over the defects that have unfortunately occurred. It must be clear to him that supervision and management appreciate his skill and the importance of his rôle. Welding operators are starving for technical guidance; they usually have no access to the laboratory or test house and consequently the necessary instruction must be given by supervision.

Advisability of Repair

Casting defects which can be repaired by welding are wellknown to foundrymen and have been described in foundry literature. It is outside the scope of this paper to describe these defects but, as a preliminary to welding any defect, it is necessary to ask certain questions: (*a*) How did the defect arise? (*b*) What is the chemical composition of the steel? (*c*) What is the service use of the casting? and (*d*) what welding process is to be used, and are special procedures required?

The answer to the first question may indicate that the defect had resulted from moulding or casting practice or from a pattern imperfection, and if the necessary remedial action is taken, repetition will be avoided. A knowledge of the chemical composition of the steel is of prime importance as this will govern the type of filler metal and the degree of pre- or post-heating employed. The service duty of

* Paper presented at the British Steel Castings Research Association's Conference held at Harrogate. The Author is chief metallurgist Head Wrightson & Company, Limited.

the casting needs equal consideration. For example, if the casting is a sprocket in a 0.40 to 0.50 per cent. carbon steel, the teeth of which are to be flame-hardened, it would be totally unsuitable to repair a defect which occurred on a tooth with a mild-steel electrode, which would not react to flame-hardening. In fact, the knowledge of the service use may rule out completely the success of any welding repair. Clearly, the chemical composition of the casting will, to a certain extent, dictate the welding process used, but the design of the casting may control the procedure. If the casting will withstand the contractional strain of the weld metal without fracture or distortion, large passes may be deposited with economic advantage. On the other hand, welding with large electrodes may cause cracking and distortion, particularly if a balanced welding procedure cannot be employed because the weld is accessible from one side only. It must also be borne in mind that, in order to avoid cracking in high-carbon alloy-steels, it may be necessary to use an austenitic weld-metal. In these cases, an incorrect welding procedure may lead to severe dilution of the weld metal by parent metal, resulting in areas of the weld metal becoming martensitic. The marked brittleness of these areas may persist even after prolonged heat-treatment.

Preparation for Welding

There are numerous methods of preparing a casting for welding; for example, grinding, flame or Arcair gouging, chipping or machining. The best method by far is machining, but this if often difficult to apply and is the most expensive, so it is probably least commonly used. Chipping with a pneumatic chisel is widely applied, but a word of warning is necessary. It is very easy to imagine that a defect has been removed when, in fact, it has only been hidden by flowing the metal over with the end of a chisel which has become blunt. In certain cases, it is essential to test with etchants, penetrant dyes, or magnetic methods, in order to ensure that complete removal of the defect has been achieved.

Where defects extend right through the wall of a casting, preparation should be made from both sides. The preparation produced should be symmetrical about the centre of the section thickness so that a balanced welding procedure can be employed and the building up of high local-stresses during welding avoided.

Whichever method is used to prepare the casting, it must be remembered that two objects are to be achieved. First, to remove completely the defect and, second, to make the welding as easy for the operator as possible. The angle chosen will depend on the welding process used, but, in general, for manual welding with stick electrodes, an included angle of not less than 80 deg. should be aimed at. However skilful a welder may be, a satisfactory weld cannot result from an incorrect preparation. Too often economic considerations alone are allowed to determine the amount of metal to be removed. It is right that the cost of carrying out a repair should always be kept as low as possible, but this fact must never be allowed to jeopardize the ultimate success of the welding operation.

Welding Operation

Effects of Welding

Before discussing the actual welding of the prepared casting, the undesirable effects that the welding may have on the casting and the way in which these may be avoided or kept to a minimum are considered briefly. The peak temperature in arc welding is highly localized and this results in a steep temperature-gradient between the molten weld-metal and the base metal a very short distance away. The rapid cooling of the weld metal and the heat-affected zones of the parent metal by the mass of adjacent cold material causes the formation of a wide variety of structures and of a very complex stress-system. The principal effects of the welding thermal cycle are:—(*a*) The production of weld-hardened zones in the parent material immediately adjacent to the fusion zone, the level of hardness depending on the carbon content of the steel; (*b*) the formation of thermal stresses which may, in turn, lead to cracking, and (*c*) the distortion which inevitably occurs, particularly when a large volume of weld metal is deposited.

In addition to these three effects, which are in a sense interdependent, there is the problem of porosity. This is caused by entrapped gases, which can originate from the breakdown of constituents in the flux coating of the electrode or from moisture picked up by the electrode coating prior to use. Gases may also be released by the reaction of elements, notably sulphur, in the parent casting, and the effect of this element can be very serious when welding in an area of the casting prone to segregation. Porosity also results from welding over entrapped sand or other contaminants, such as grease, dirt, etc., which may have been introduced into the joint during or after preparation.

Preheating

It is clearly possible to minimize all four of these effects by slowing down the heating and cooling rates associated with the welding thermal-cycle. This can be achieved by preheating and by controlling interpass temperatures. Preheating will reduce the temperature gradients and result in a slower cooling-rate, thus encouraging the austenitic transformation to occur at higher temperatures and avoiding the formation of martensite in the weld-hardened zones. Additionally, the slower cooling-rate will also lower the internal stresses set up in the area of the weld during cooling and thus lessen the tendency for cracking and distortion. Another important effect of reducing the rate of cooling is that more time is available for the entrapped gases to escape, which will have a marked effect in cutting down porosity, and, in the case of low-alloy steels, reducing the cold-cracking tendency, which has been shown to be strongly influenced by hydrogen.

From the foregoing, it will be appreciated that the temperature of preheating is exceedingly im-

portant and must be chosen with care. Clearly, it should be as low as possible because of cost, and also because with preheat temperatures in excess of 200 deg. C., the protection of the welder poses difficulties. The most important factor, however, governing the preheat temperature is the chemical composition of the casting. Steels low in carbon and alloy content require little or no preheating as they do not harden excessively. In general, if the carbon content is below 0.30 per cent. in plain carbon steels, preheating is unnecessary. Preheating temperatures between 100 and 200 deg. C. are required for castings having a carbon content of up to 0.50 per cent. and where the alloy content is also high, temperatures of up to 350 deg. C. may be required.

The size and shape of the casting, together with the size of the repair, also control the preheat temperature. In general, the greater the cross-section of the casting, the higher the preheat temperature. Also, complex castings consisting of both thin and thick sections merit special consideration as the thinner sections will cool faster, which can lead to severe internal stress and the likelihood of cracking. As the main object of preheating is to retard the cooling rate, it is essential that the casting be protected from draughts and, in special cases, it may be necessary to build a temporary protection round the casting or furnace cool using a programme controller.

Infrequently tack-welding is a necessary preliminary to the welding proper and this should never be undertaken without preheating. The quenching effect of the mass of cold metal is immense and it is highly probable that cracking in the heat-affected zones, or weld metal, will occur, even in plain carbon steels with less than 0.25 per cent. carbon, where small tack welds are used. For similar reasons, the welders should never be permitted to strike their arcs on the cold casting.

Whenever possible, preheating should be carried out by treating the entire casting in a furnace, thus enabling accurate temperature-control to be achieved and temperature gradients avoided. Local preheating by means of gas torches may have to be employed, but while this is successful in retarding the cooling rate in the area of the weld, it may introduce large stresses adjacent to the heated area. The initial preheat should remain on the casting until welding is completed. In small compact castings, the welding heat may maintain the preheat temperature or even raise it locally. The interpass temperature must be controlled so that it never exceeds the initial preheat temperature by more than 100 deg. C. If the welding heat is insufficient to maintain the desired degree of preheat, it may be necessary to supply additional heat by locally heating with gas torches or by heating the entire casting in a furnace.

Choice of Method

Three factors must control the selection of the welding method used. These are: (*a*) Cost, (*b*) rate of deposition, and (*c*) metallurgical quality of the deposit. The most important of these is metallurgical quality, and if more than one method provides this, then it is necessary to weigh the high deposition rates (<20 lb. per hr.) of the semi-automatic methods with high material and operating cost against the comparatively cheap method of manual welding with covered electrodes, having a deposition rate of <5 lb. per hr. Semi-automatic welding methods are comparative newcomers to foundry welding practice, but their use is increasing, and an investigation carried out by a large steelfoundry in Canada showed savings of over 50 per cent. when comparing these methods with manual welding using covered electrodes in the repair of a heavy steel casting.[1] On the other hand, the advent of the iron-powder electrode has increased the deposition rate which can be achieved with covered electrodes (<10 lb. per hr).

Methods of Welding

Metallic Arc Welding with Covered Electrodes

More than 90 per cent. of welding carried out in steel foundries to-day is by metallic arc using covered electrodes and, in spite of the growing interest in semi-automatic methods, this state of affairs is likely to remain with us for many years to come. Many types of electrodes are available and wherever possible an electrode should be chosen which will deposit weld metal having a similar chemical composition to the casting being welded.

The quality of welds on alloy steels has been greatly improved over recent years by the judicious use of low-hydrogen electrodes. However, their greatest drawback is the susceptibility of the coatings to moisture. If porosity and cracking troubles are encountered when using low-hydrogen electrodes, it will usually be because the electrodes have been stored under unsatisfactory conditions, resulting in moisture pick-up in the coating. The electrodes should be stored in a cabinet maintained at a temperature of 120 deg. C. and opened packets should never be left lying around the shop floor for any length of time, the welder only being issued with sufficient rods to complete the job in hand.

Considerable savings are possible by the use of iron-powder electrodes, *i.e.*, electrodes which have coatings loaded with considerable amounts of iron powder. It is claimed by the manufacturers that welding speeds are doubled by the use of these electrodes in comparison with the usual rutile-coated type. Recent work by the Author has, in general, confirmed these claims, as is shown by the results given in Table 1. As a result of the iron

TABLE 1.—*Deposition Rate of Iron-powder and Rutile-coated Electrodes.*

Electrode size.	Deposition rate, lb. per hr.	
	Iron powder.	Rutile.
10 s.w.g.	3.41	2.19
6 s.w.g.	6.98	4.10
4 s.w.g.	9.40	4.60
¼ in.	11.43	6.79

powder in the coating, the outside diameter of iron-powder electrodes is greater for a given gauge of electrode than for the normal rutile-type, and this may mean that, in order to weld satisfactorily

at the bottom of a prepared groove, a smaller gauge of electrode has to be used; this can reduce some of the advantage claimed.

Low-hydrogen iron-powder electrodes are also available for both carbon and low-alloy steels. These electrodes have both the advantages and disadvantages of the individual types.

Manufacturers indicate the recommended current ranges for their electrodes on the containers, and these currents should be followed. The ranges are usually wide and the higher currents should be used for straightforward downhand welding, while those at the lower end of the range should be used for positional welding, or where careful control of the weld metal is needed.

Experienced welders can usually be relied upon to select the appropriate current, but a tendency to use the higher currents in order to increase output may occur and must be stamped out if poor-quality welds are to be avoided. This tendency is one objection to the application of piece rates to welding repair.

Tungsten Inert-gas Arc Welding (TIG)

The inert-gas arc welding process consists of an arc maintained between the base metal and a tungsten electrode surrounded by an inert-gas atmosphere, filler rod being fed into the weld pool after the manner of oxy-acetylene welding. The inert-gas can be either argon or helium, the former being almost exclusively used in this country. The purpose of the inert-gas atmosphere is to shield the weld pool from the atmosphere thus preventing contamination by oxygen and nitrogen. It is often erroneously thought that the shielding gas acts as a flux, but this is not so. The gas is inert and merely prevents contamination of the weld pool taking place: it will not remove contamination which is present in the prepared groove before welding commences. Accordingly, if the full advantages of the method, *viz.*, denser and cleaner weld-metal, are to be achieved, meticulous preparation prior to welding is a necessity.

The cost of TIG welding is relatively high and its use is normally confined to special applications where it is essential to have a weld metal of matching composition and no coated electrode is available. The foundry will then produce a cast welding-rod which can be used to make homogeneous repairs on castings that would otherwise have to be scrapped. TIG welding has also been used for modifying patterns in aluminium or magnesium alloys, but with these materials, alternating current with super-imposed high-frequency is recommended, instead of direct-current electrode negative used for welding steel. This process should not be used for welding incompletely "killed" steel, as the gases given off during welding interfere with the welding process and can result in porosity.

Metal Inert-gas Arc Welding (MIG)

The metal inert-gas arc welding process comprises a coiled filler wire which is automatically fed as a continuously consumable electrode surrounded by an inert-gas atmosphere. Wires are available of from 0.035 to $\frac{3}{32}$-in. dia. and are obtained already coiled on spools. The process may be fully automatic or semi-automatic, the latter, using the larger diameter wire, being most suitable for foundry application. Deposition rates with the MIG process are up to four times greater than those obtained with coated electrodes (>16 lb. per hr., as compared with 4 to 5 lb. per hr.). This process is particularly suitable for the repair of large castings when appreciable quantities of deposited weld metal are required. The shielding gas for MIG welding is usually argon, with small amounts (1 to 5 per cent.) of oxygen to stabilize the arc. This mixed gas is normally referred to as "Argonox." The consumption of gas is high—45 cu. ft. per hr. minimum—and hence the process is expensive to operate except for special applications involving materials such as stainless steel.[2]

Carbon dioxide, which is much cheaper than "Argonox," is now being used successfully as a shielding gas for the fabrication of wrought mild steel and the so-called CO_2 bare-wire process is just breaking into the field of steel-casting repair and fabrication.[3]

It should be noted that the intensity of radiation from the arc is much greater with MIG welding than with normal arc-welding processes and special welding screens are necessary.

Submerged-arc Welding

In the submerged arc process, a layer of granulated flux completely surrounds the arc between the bare-wire electrode and the job. Since the arc is covered by a flux blanket, the operator does not need a welding screen and, of course, cannot observe the arc during welding. The coiled electrode-wire is fed continuously through a nozzle from a reel, while flux is gravitationally supplied from a flux hopper around the arc. The action of the flux is twofold—in addition to shielding the weld metal from atmospheric contamination and cleansing of impurities, it can be used to impart alloying elements to the deposit. A submerged arc flux is available from one supplier, which can be mixed to provide weld metal of any desired composition when used in conjunction with a filler wire of standard composition. Fully-automatic and semi-automatic equipment is available, the latter being most suitable for foundry applications. It is possible to deposit up to 20 lb. of metal per hr. using currents of 700 amp., and this process is probably the most economical means of making extensive repairs on carbon or low-alloy steel castings.

Electro-slag Welding

No list of available welding processes would be complete without mention of the electro-slag process. Originally developed in the USSR some 12 years' ago, this process differs from the conventional arc-welding processes in that there is no arc once welding equilibrium has been established. The heat necessary to melt the electrode wire and fuse the sides of the parent metal is derived from the passage of current through the electrically-con-

ductive molten slag. Welding has to be carried out in the vertical or near vertical position, water-cooled copper shoes being used to retain the molten metal and slag bath. The shoes are connected to the carriage of the welding machine which moves up the seam as welding proceeds. In short, the process is like continuous casting.

Equipment is available which will weld material

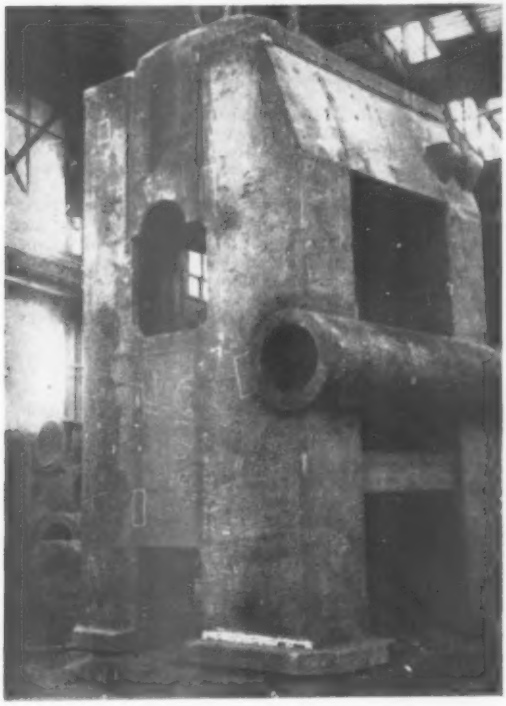

FIG. 1.—*A 4,000-ton press-frame fabricated by electro-slag welding.*

up to 20-in. thick in one pass and, in the USSR, it is widely used in the field of casting fabrication. The process is clearly unsuitable for the repair of normal casting defects. The principle of eletro-slag heating has been applied in the USSR to the feeding of ingots and encouraging results have been obtained. In this application, non-consumable graphite electrodes are used instead of filler wires.[4]

In the past, oxy-acetylene welding, carbon-arc welding and "Thermit" welding have been used in the repair and fabrication of steel castings. These processes, however, find little application today, except in isolated cases.

Post-welding Treatment

Most castings in plain-carbon and low-alloy steels can be allowed to cool in still air after welding. However, with certain materials, such as the 5 per cent. Cr/Mo steel, it will be necessary to retard the cooling rate, and this is best carried out by furnace treatment immediately welding is completed. If cold cracking is to be avoided, the welding heat must not be allowed to escape from the casting before the post-weld heat treatment is given. With the possible exception of some low-carbon unalloyed steels, all castings should be given some form of post-weld heat-treatment. This may range from stress-relieving in the temperature range 600 to 650 deg. C. to a full normalizing treatment at 830 to 880 deg. C., or even the specified quench and temper. Any of these treatments will be effective in reducing the residual stresses to an acceptably low value as well as eliminating the well-hardened zones.

In deciding the type of treatment to be given, attention must be paid to the effect of the heat-treatment on the properties of the weld metal, as distinct from the heat-affected zones or unaffected base steel. In general, electrode deposits are lower in carbon than the castings being welded, and, in spite of the dilution which occurs when welding, the deposited weld metal is also lower in carbon than the casting. In order to compensate for the lower carbon-content, the manganese and silicon contents of the welding electrodes are frequently higher than in the castings, and this serves to give the weld metal mechanical properties in the as-deposited condition which match those of the casting. Post-welding heat-treatments, other than stress-relieving at 600 to 650 deg. C., can result in a marked lowering of the mechanical properties of the weld metal, this effect being particularly marked with the so-called high-tensile electrodes (Table 2).

TABLE 2.—*Effect of Normalizing on Mechanical properties of Low-hydrogen Weld Metal.*

Condition.	Tensile strength, tons per sq. in.	Yield strength, tons per sq. in.	Elongation per cent. on 2 in.
As welded and stress relieved at 650 deg. C.	34.5	29.5	33
Normalized 880 deg. C.	28.0	22.0	48

Under exceptional conditions, it may not be possible even to stress relieve a casting after welding and, in these circumstances, peening may be contemplated as a method of obtaining mechanical stress relief. It is also claimed that peening minimizes distortion. There is no doubt that deep inter-pass peening does result in a degree of stress relief, but the procedure is so prone to abuse, resulting in weld metal cracking, that it is best avoided.

Acknowledgment

The Author is grateful to the directors of Head Wrightson Steel Foundries, Limited, for permission to publish this paper.

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[2] F. P. Y. Arseneault, "Welding Repair of a Giant Turbine Runner," *Canadian Metals*, 1957, **20**, (2), 34-40, and 1957, **20**, (3), 46-51.

[3] T. J. Chyle, "Carbon Dioxide Welder makes Casting Repair Easier," *Steel*, 1958, **143**, 17 Nov., 110-112.

[4] J. S. Tyagum-Belous and D. A. Dudko, "Electro-slag Heating of the Heads of Ingots and Shaped Castings, using Non-consumable Electrodes," *Avtomaticheskaya Svarka*, 1958, (10), 36-43. British Steel Castings Research Association Translation No. 129/JHD.

Equipment and Supplies

Sand-cooling Plant

The advent of air-hardening and CO_2 processes in coremaking have introduced the problem of obtaining a continuous supply of cold dry sand in foundries, but Parker Mitchell Engineering Company, Limited, Thornliebank Industrial Estate, Glasgow, claim to have overcome difficulties with new plant developed. The generally-accepted method of obtaining a supply of cold dry sand is by the application of heat to the wet sand in a rotary or static drier to drive off moisture, followed by cooling in a water-jacketed drum or leaving the sand to cool naturally in atmosphere. Application of heat is quite simple. Conversely, when cooling is required, normal cooling-media (water or air) are usually limited to ambient temperatures. It is clear, however, that to utilize fully either of these mediums and accelerate cooling as far as possible, it is necessary to separate the sand grains and bring them into complete contact with the heating or cooling medium, thus facilitating maximum heat-transfer. Water-cooling was rejected as impracticable, but suspension of sand in air can provide both a practical and efficient means of achieving the desired end.

This method of sand cooling has, of course, been attempted in the past by means of a fan and duct (Figs. 1 and 2), but, it is contended, has never been wholly successful. The method illustrated in Fig. 1 has the disadvantage that, as the flow of sand cannot be accurately and constantly related to the volume and speed of air being passed, sand gradually builds up in the horizontal part of the duct and chokes it. Also, excessive wear may take place at point "A," due to abrasion. In a revised method shown in Fig. 2 —designed to avoid abrasion—the major source of trouble is again due to inadequate flow-control. It can be seen from this illustration that when the flow is in excess of the capacity of the fan, there is a fall back of sand into the fan casing, and when shutting down this disadvantage becomes more apparent.

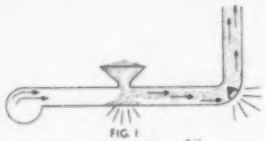


FIG. 1. — *One method of cooling sand. Due to lack of control, sand flow cannot accurately be related to volume and speed of air; sand can build-up in the horizontal part of the duct and excessive wear can occur at point "A."*

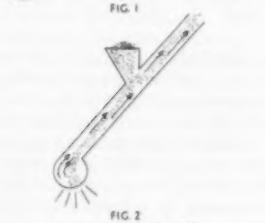


FIG. 2.—*Another method for cooling sand; note the fall-back of sand into the fan casing owing to inaccurate control of flow.*

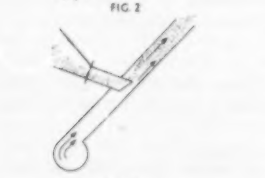


FIG. 3.—*Method of cooling sand introduced by Parker Mitchell Engineering Company, Limited. Here, a feed chute is so designed that the sand flow is trapped at its angle of repose and unable to fall back into the fan casing.*

To overcome these difficulties, it appears obvious that a control valve is required which will accurately relate the sand flow to the air speed and volume, and seal the flow from the fan immediately the plant is stopped. This, it is claimed, has been successfully achieved by Parker Mitchell by their development of a feed chute (shown in Fig. 3). This chute is introduced into the duct just above the fan and is so designed that the sand flow is trapped at its angle of repose and is not—under static conditions—able to run through into the fan casing. When the fan is switched on, air passes through the feed chute and raises the sand into the main air-stream, which carries it up the duct to a settling chamber and from which it is deposited into a storage hopper. This design gives a completely automatic flow valve with no moving parts and incorporates a straight main-duct, thus wear in the plant is negligible. It is claimed by the company that the only maintenance required is to the fan itself. With this type of installation, the makers claim that, using a 1 h.p. motor, one ton of sand can be elevated at the rate of 20 ft. per hr., accompanied by a temperature-drop of up to 70 deg. C. (An installation of this equipment is reported to be operating with full satisfaction at Maitlands (Ironfounders), Limited, at Airdrie, Lanarks.)

Thermocouple Connector

West Instrument, Limited, Regent Street, Brighton, are producing a new type of thermocouple plug and socket, claimed to be notable for its compactness, cheapness, oil- and water-tight design and its elimination of the errors often introduced at the union with extension wiring. The manufacturers also state that the new type eliminates the need for terminal strips and other types of connectors which could cause errors in temperature readings because of vibration, dirt and other factors. The pins and sockets of the connector are made of thermocouple materials to prevent spurious e.m.f.'s being produced as a result of temperature gradients over plug and socket, and the connectors are polarized to prevent faulty connections. The dimensions of the unit are approximately $\frac{7}{8}$-in. dia. by $1\frac{1}{2}$-in. long.

Chroffles

W. Canning & Company, Limited, Great Hampton Street, Birmingham, 18, are now marketing ball chroffles made from Rigidex high-density polyethylene. They are spherical in shape, with a diameter of approximately $1\frac{1}{4}$ in., and are supplied for use in plating and pickling tanks, where they float on the surface of the liquid and form an inert blanket which, it is claimed, minimizes spray and splashing of dangerous solutions, reduces busbar and ducting corrosion and provides an additional safeguard for plating-shop staff. The chroffles are suitable for temperatures up to 93 deg. C. and are resistant to most acids and alkalis.

Silica Analyser

The silica analyser, model 58A, manufactured under licence by Electronic Instruments, Limited, Richmond, Surrey, is claimed to be the first commercially-available automatic instrument that continuously analyses the silica content of boiler-feed-water. The instrument, 34-in. high, 17.5-in. wide and 12-in. deep, is available in three ranges, 0 to 0.2, 0 to 2.5, and 0 to 3.0 parts of silica per million of water.

Fixing of Brackets on Patterns

By "Checker"

The use of brackets on castings is common in malleable-iron practice and is sufficiently widespread in steel and other branches of founding to make the following of general interest. This article does not discuss the metallurgical principles involved but deals instead with the pattern-making aspect and detailed methods of application.

The production of a sound casting can sometimes best be achieved by incorporating brackets—or ties—into the cast-shape, at stressed-sites. Their main purpose being to prevent cracks in the castings by applying support of the correct size, and thickness, in the correct place, they should be fixed on the pattern, in order to be most effective. Often a pattern from which malleable castings are made will have several brackets placed in appropriate positions.

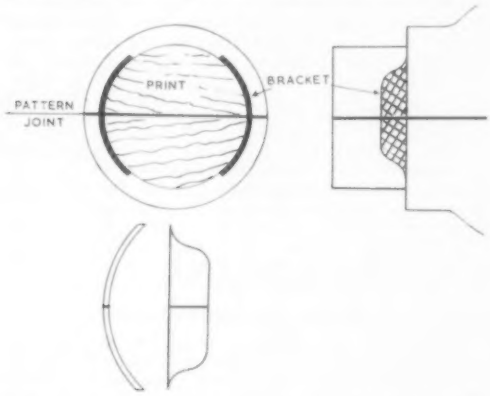


FIG. 1.—*The bracket shown on this pattern is split at the joint, and fastened flat against the print halves.*

In most cases it is advisable to attach these brackets after the main pattern-shapes have been completed. Their thickness may vary according to individual requirements, but $\frac{3}{32}$, $\frac{1}{8}$, or $\frac{3}{16}$-in. thickness is usually sufficient. Because they are so thin, it is better to make them from sheet metal, such as aluminium or brass instead of wood.

Examples

Fig. 1 shows a bracket fixed on each side of the pattern joint, and shaped to rest on the core-print circumference, each bracket being in two parts, one on each half-pattern, separately, as shown. The fixing of this type of bracket presents no difficulty to the patternmaker as it can be nailed on to the print side, or, in the case of metal patterns, held by small rivets. Fig. 2 illustrates a bracket placed at the bottom of a rib at the junction where it meets the main-casting shape. Here the means of attachment must be different from that in the first example, for it is impossible to rivet or nail it securely in postion in the normal manner. Therefore to make the bracket firm and secure, when in position, two legs are included when cutting it out. It is important that the legs are parallel with each other, and to make fixing easier, a slight taper should be included in their length, as shown in the diagram. To fasten these brackets into the wooden patterns, a hole should be bored slightly smaller than that of the thickness of the legs, and they can then be knocked into position. Following this, a fillet of a reasonable size should be added at each side of the bracket. To achieve a good pattern withdrawal, care should be taken when

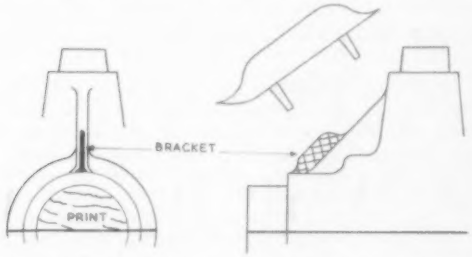


FIG. 2.—*The projecting bracket here illustrated must carry its own rigid means of fastening so that it is located in correct alignment with the pattern.*

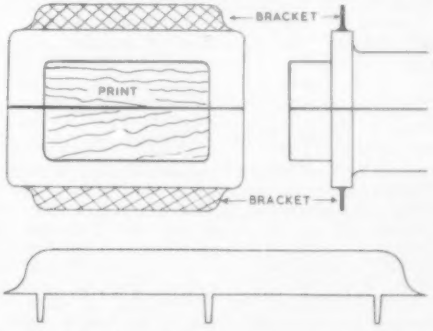


FIG. 3.—*This long bracket is secured similarly to that in Fig. 2, being carefully radiused so that its cast shape blends smoothly into the parent flange.*

Fixing of Brackets on Patterns

positioning the brackets to ensure that they are perfectly upright. Indeed, to avoid the possibility of an undercut, a slight taper each side of the

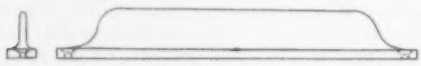


FIG. 4.—*The other figures give examples of the position of brackets seen as additions to existing-patterns. In this instance the bracket is designed to be made integrally with the main-body of the pattern. It therefore carries a suitable base which may be let into it, and screwed as a permanent-fixture.*

bracket should be applied, before fixing it in position.

Another illustration is given in Fig. 3, where the brackets are approximately 16-in. long and 1¾-in. deep, and fitted on to the top and bottom parts of the flange, extending for almost the full length. These have three legs included, to give a secure hold to the wood pattern. It will be noticed that all the brackets have a good radius at the ends to give a satisfactory blend into the main casting-shape.

Sometimes it may be considered better to make the bracket and side radii integrally, instead of adding them separately. In such cases master patterns can be made to include these, sufficient depth being left at the bottoms for recessing into the wood. Fig. 4 illustrates how this may be done, by allowing small terminal flanges to take the fastening screws. Although the examples given are of brackets on patterns, the principle may clearly be applied to internal brackets in castings, by incorporating them in a similar manner in core-boxes.

Wm. Aske Expansion

Wm. Aske & Company, Limited, foundry suppliers, of Halifax, have acquired Springwood Mill, a six-floor building at Holywell Green. Extensive structural alterations are to be made and the company plan to move a number of departments, including the laboratory and research station, from Halifax by next summer. It is stated that existing premises at Waterside and Boothtown are inadequate to cope with expanding business and there is no longer sufficient accommodation for the laboratory, central offices and certain works departments.

The main floors of the mill will each provide over 13,000 sq. ft. of floor-space, and one of them is to be equipped as the laboratory, giving the additional space urgently needed for research. A new dispatch department is envisaged, and the existing office accommodation will be used for reception. The new premises will be known as Springwood Works and once the offices and laboratory have been moved there, the future of existing Halifax premises will be considered.

Tata Iron and Steel

Deterioration in the quality of coal and iron ore and delays in the transportation of raw materials over a heavily strained railway system are blamed by Mr. J. R. D. Tata, chairman of Tata Iron & Steel Company, Limited, Bombay, for the company's failure to reach, in the past financial year, a rate of production nearer to the planned capacity of its expanded plant. The company is confident, however, that various measures when completed will enable the works to achieve, and possibly exceed, the full target output of 2,000,000 tons of ingots and 1,500,000 tons of saleable steel.

Mr. Tata, in his statement to shareholders, says that the year to March 31, 1960, had been a full and significant one, which saw the completion of the biggest expansion prgramme ever undertaken in the history of the company, and the introduction of a new wage structure following three years of intensive studies and negotiations. About half of the company's plant was now wholly modern, and the additional 1,000,000 tons capacity had been put up in gratifyingly quick time and at relatively low cost.

The company had spent on it approximately Rs. 1,060,000,000 (£79,500,000), and even if the total costs came to Rs. 1,100,000,000 (£82,500,000), including the costs of certain modification and additions, it would still amount to only Rs. 1,100 (£82 10s.) per ton of ingot capacity. The same capacity in an entirely new integrated steel plant would cost at least Rs. 1,800 (£135) per ton, or over 65 per cent. more.

Difficulty over Raw Material

In spite of the difficulties regarding quality and supply of raw materials, the company had already stabilized production at a rate equivalent to about 80 per cent. of full capacity—a figure which in most countries would be considered quite good. Added to the difficulties which the company had to overcome to get full production was the need for certain modifications and additions to the ore-crushing and screening plant and to steel melting shop No. 3. Some of the remedies required action by the company, others by the Government, but in both cases action had already been initiated, or was being planned.

Brass Foundry Changes Hands

Negotiations were completed last month for the take-over of the Ayr firm of Alexander Ferguson (engineers and brassfounders), Limited, by the Scottish industrial holding company, Grampian Holdings, Limited. The price agreed was £35,000.

The Ayr firm employs about 30 workers in the manufacture of "Eclipse" jointing and non-ferrous couplings used in engineering and shipbuilding. Its owner, Mr. Alex. Ferguson has been engaged in brassfounding for 62 years. Only in the past 13 years has he made his own products. Previously he engaged other firms to make his designs, which he sold. After operating for many years from the headquarters in St. Vincent Street, Glasgow, he decided to establish his own foundry and he set up his present premises in Ayr in 1947.

During the past year the profits of the company totalled £10,084. The price paid for it is made up of £12,000 in cash and 11,500 seven per cent. cumulative preference shares and 9,200 ordinary 5s. shares in Grampian Holdings, all credited as fully paid.

Mr. JOHN HOLLINGS, chief designer of Rolls-Royce and Associates, Limited, has been appointed a director.

Employer's Liability for Latent Dangers in Tools supplied to Employee

By "Barrister-at-Law"

A question of far-reaching importance to all employers, particularly founders who supply tools of any sort to their workmen (even hammers and chisels), was raised recently before the House of Lords in the case of Davie *v.* New Merton Board Mills, Limited. In that instance, the employee claimed damages against his employers for injuries received as a result of a hidden defect of manufacture in a tool which they had purchased. The point in issue was whether employers were under an *absolute* obligation to provide their employees with proper tools and other materials with which to work. Putting the matter in another way, could an employer be liable to his employee for the negligence of a manufacturer, who had no contractual relations whatsoever with the employer and whose relationship with the employer could not be put higher than that of an independent contractor.

General Rules of Liability

The general rules governing liability for wrongs, is that a person is responsible for the negligence or wrongful acts of himself and of his servants or agents, in so far as the latter are acting within the scope of their employment. He cannot, however, be made liable as a general rule for the wrongful acts of an independent contractor.

Whether one person stands to another in the relationship of servant or agent on the one hand, or of independent contractor on the other, depends on whether or not he is under the control or direction of the person engaging him. If the latter has no right to direct him as to *how* he is to do his work, the relationship would be that of independent contractor; on the other hand, if the right of such direction exists, then the relationship would be that of master and servant.

Thus, for instance, if one engages a builder to do work to a building, the builder is an independent contractor, and the person engaging him, in general, is not liable to third persons for damage suffered by his negligence.

What the employee was seeking to establish as a principle of law in the above case apparently was either that the above rule of exemption for the acts of an independent contractor was wrong, or that there were exceptions to that rule, the circumstances of the case in question constituting such an exception.

The material facts were shortly as follow:—The employee in question, who was a maintenance fitter, was knocking out a metal key by means of a drift and hammer, when a particle of metal flew off the drift and entered his eye, thereby causing him injuries. The drift had been manufactured some seven years previously, and the employers had purchased it from a reputable firm of suppliers to whom the manufacturers had sold it. The defect in the drift was latent, and not apparent, and no fault could be found with the employer's system of maintenance and inspection.

The House of Lords held that the employers could not be held responsible. The manufacturers could not be said to have been the employer's agents for providing the workman with the tool. And even if they could be regarded as independent contractors, the employers could not be held liable. The House of Lords, however, in any event, thought it was stretching the matter somewhat to describe the manufacturers as independent contractors of the employers. The latter had never contracted with the manufacturers, and indeed, may never have even heard of them, and as the House of Lords put it, may even have been divided from them in time and space by decades and continents. If indeed the law was, as was being contended on behalf of the workman, then every person employing another and supplying him with tools, or other articles in connection with his job, would be acting at his peril, and would be absolutely liable for any injuries suffered, however blameless he might be. This doctrine must be regarded therefore as having now been finally rejected by the Courts.

Conclusion

This decision it is to be observed applies to latent defects, which cannot reasonably be expected to be discovered. It seems that it does not apply to cases where the defect would be obvious to any skilled person, or where it could reasonably be expected to be discovered on a proper inspection, or on the course of proper maintenance of plant and equipment and the like. This decision is of extreme importance to employers, and the principle of this decision may apply to a variety of circumstances, in any type of plant. There is extensive use of hand-tools in foundries and it may be that many of these would be supplied by manufacturers in a contractual relationship with the foundry owners, who should note their liabilities in these circumstances. On the other hand, according to this principle a foundry owner could not be held liable for injuries suffered by an employee, for instance, while climbing a ladder, or steps provided by the employer, which happened to be defective because of some latent fault of which the employer was unaware, and which the employer could not have been reasonably expected to discover.

DSIR and Shipbuilding Research

A warning that shipbuilding costs are too high to meet foreign competition, and that the industry may be facing a prolonged recession was given in a report published at the end of last month by the Department of Scientific and Industrial Research. The report said that the British industry is facing "very severe competition for orders," and without cutting costs might not be able to retain is share of the market when demand improves. Production would have to be cut in the next few years.

The Shipbuilding Conference, in a statement issued the same day, said the release of the published report was with the knowledge and concurrence of the industries concerned. "It is hoped that publication will now put an end to erroneous and damaging speculation about its contents which have appeared in the Press in recent weeks. A draft report, which gave rise to these speculations, has been the subject of detailed discussion between the industry and DSIR, and the inaccuracies which led to strong opposition to its publication have now been corrected."

The statement adds: "The report contains a number of criticisms, but shipbuilders and marine engineers welcome constructive suggestions, and are anxious that their research activities should be as comprehensive and forward looking as possible. . . While the industry accepts that the intention of the DSIR report is to be helpful towards these objectives, it is by no means in agreement with some of the comments and views expressed, especially as regards achievements in the field of marine engineering."

The DSIR report, compiled by the Department's economic committee, criticized shipbuilding for spending less than other industries on research and development; blamed labour relations and the impracticability of shift work for slowing the introduction of new methods and handicapping the best use of space and machinery. It suggested concentrating production, with more standardized equipment and components.

Comment

Commenting on the report last month, Col. T. Eustace Smith, president of the Shipbuilding Conference, said in Middlesbrough: "The British shipbuilding industry is a good as, if not better than, that of any other country. The report was "not a report on the industry as a whole, and ought not to be read like that. It should be a report simply on research."

"Because we are in difficulties, it does not mean that the rest of the world is all right. The Continental shipbuilders are in just as much difficulty, and Japan is even worse off. In Holland and Germany they are having to import labour from Italy and Spain. Their costs are rising rapidly."

Mr. E. J. Hunter, chairman of Swan, Hunter, & Wigham Richardson, Limited, shipbuilders and engineers, speaking at South Shields recently, said that there were signs that British yards were again beginning to lead the world, and with the passing of time, this lead would emerge more clearly.

Mr. Hunter said he wanted to correct the impression, created by the DSIR report, that the time taken in building ships in Britain compared unfavourably with that abroad. Swan Hunter and other yards were well capable of good construction performances, and the company itself had one ship planned for next year which would take no more than eight months to build. This was a far cry from the average construction time of 18 months, quoted in the report.

New Year Honours

Among the large number of men and women figuring in the New Year Honours List are many in the spheres of industry and commerce, including a number of prominent personages in the foundry and iron and steel industries. Details of some of the principal awards, with notes on recipients, are given in what follows, and the list will be concluded in next week's JOURNAL.

BARON

Sir ALEXANDER FLECK, chairman of the Advisory Council on Research and Development, Ministry of Power, and of the Nuclear Safety Advisory Committee. Sir Alexander recently retired as chairman of Imperial Chemical Industries, Limited, on the main board of which he had served since 1944. He was chairman of the Billingham division of ICI from 1937 to 1945, and during his service as deputy chairman (1951-53) and chairman (1953-60) of the company's main board he played an important part in the vast developments at Witton. A past-president of the British Association, he has been a director of the Midland Bank, Limited, since 1955.

KNIGHTS BACHELOR

Mr. G. E. BEHARRELL, chairman of the Dunlop Rubber Company, Limited, which he joined in 1928. The chairman of a number of Dunlop subsidiary and associated companies, he was a member of the Iron and Steel Board from 1953-57. His father, Sir George Beharrell, was for many years head of the Dunlop Company.

Mr. GEORGE GORDON HONEYMAN, a chairman of the Industrial Court since 1949, and a member of the Industrial Disputes Tribunal from 1951 until it ended its work in 1959.

ORDER OF ST. MICHAEL AND ST. GEORGE

CMG

Mr. JOHN COLBURN BENNETT, joint managing director, Henry Gardner & Company, Limited, metal merchants and brokers of London, E.C.2, and a director of Amalgamated Metal Corporation, Limited, holding company holding the share capitals of the British Metal Corporation, Limited, and H. Gardner & Company, Limited, for services as advisor to the Board of Trade.

ORDER OF BRITISH EMPIRE

CIVIL DIVISION

CBE

Mr. JOHN ARMITAGE DRAKE, chairman and managing director of Drakes, Limited, constructional gas engineers, of Halifax, a concern founded by his great grandfather in 1847. He is also chairman of a number of subsidiary companies, including F. C. Sugden, Limited, gas and chemical engineers, and John Morton (Fireclay), Limited, of Halifax. Mr. ARTHUR ALEXANDER RUBBRA, technical director, Rolls-Royce, Limited, Derby, who has served with the company for 35 years. In 1940 he was appointed chief designer of the company and in 1944 assistant chief engineer. He became deputy chief engineer in 1951. Mr. JAMES BRYAN SCOTT, sales director of Crompton Parkinson, Limited, electrical engineers of Leeds, and a director of a number of subsidiary companies including British Electric Transformer Company, Limited, Cooke & Ferguson, Limited, Derby Cables, Limited, and Young Accumulator Company, Limited. Mr. Scott is a member of the council advising on the organization of the British Trade Fair in Moscow this year.

American Letter

US Steel Foundry converted to Shell Moulding

Indiana Harbor Works of American Steel Foundries is said to be the first steel foundry in the US to be converted completely to shell moulding, and the only foundry in the country producing castings over 200 lb. in weight by this process, the company's smallest production castings weighing about 15 lb. Several other American foundries using the shell-moulding process produce castings weighing generally below the 15-lb. range.

After eight years' of laboratory work by the group, a pilot plant was set up in 1957 to determine the feasibility of large-scale production of both large and small castings by the shell-moulding process. This was considered successful and the conversion of the Indiana Harbor Works for shell moulding was commenced in 1959 and was completed in July, 1960. The result of the conversion is that the company is producing castings to much closer tolerances with the shell process than was formerly possible with greensand moulding, and, according to the works' manager, Mr. R. L. Jones, the more-accurate metal patterns produce every mould to more exact dimensions. Cores from metal coreboxes are also to equally close dimensions.

Type of Production

The weight of one valve-body in the 4-in. size range produced by the company's foundry was reduced from 65 to 55 lb. in weight, said Mr. Jones. This reduction was possible because the reproducibility of uniform wall-thickness as a result of shell moulding, eliminated the need for the excess wall-thickness necessary with the greensand method as a safety factor to guard against the possibility of variation in section. The number of machining operations on the valve body was also cut from eight to five.

One of the largest shell castings being made by American Steel Foundries is a "fifth wheel," weighing about 225 lb. This is an attachment device for coupling highway-truck tractors to their trailers. Other castings include tractor sprockets and rollers, industrial valves, power-shovel tooth-points and other wear-resistant parts. Company-designed products, such as brake beams and friction shoes for the railways and fifth wheels for trucks account for a substantial part of the company's present production.

Advantages of Shell Moulding

The thickness of the shell mould is less than 1 in., and requires only a fraction of the sand needed in the greensand process. The shell mould for a 125-lb. brake beam requires 205 lb. of shell sand as compared with 1,650 lb. of greensand. The price of zircon sand —the base for shell moulds for steel—in the US is about $70 per ton—10 times that of greensand—but is said to be competitive cost-wise, because it can be reclaimed at least 10 times. The zircon sand used is obtained from Florida, but a competitively-priced zircon sand is available from Australia. However, American Steel Foundries has not yet used this imported sand.

Sand

About 400 tons of sand is kept in the foundry's sand system at all times and, after each use it is returned to the reclamation system. The loss of sand per cycle is stated as being less than 10 per cent. The original sand is about 130 AFA grain-fineness and all sand which passes through a 20-mesh screen in the reclaiming operation is discarded. Phenolic resins and other materials are added to the sand to give the necessary bond.

Patterns and Equipment

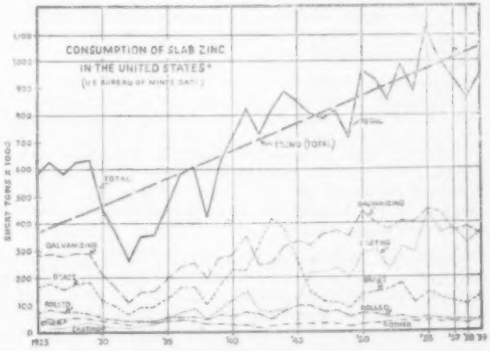
Patterns used by the company are of precision-machined cast iron. The wear on patterns in use is reported to be negligible and in some cases, well over 100,000 moulds have been produced from a single pattern. Three sizes of moulding machines are used, to produce shells of 26 in. by 40 in., 26 in. by 80 in., and 44 in. by 55 in., seven machines being installed, three of the small and two each of the larger sizes. Melting equipment at American Steel Foundries consists of two 10-ton and one 5-ton basic electric furnaces and the inspection equipment includes 250,000-v X-ray apparatus, both wet and dry magnetic-particle and ultrasonic equipment. (The monthly capacity of the shop is 1,800 tons, but its present operating rate is much lower. Present employment is about 300).

Competition with Forgings

Closer tolerances in steel castings obtained with the shell-moulding process are enabling American Steel Foundries to compete price-wise with forgings in the 100 to 300 lb. weight range. In this range, steel castings made by the traditional greensand process had been competitive with forgings, but because of shell moulding, the company hopes to acquire even more industrial business from its traditional forging competitors.

US Consumption of Zinc, Lead and Tin

Increasing use of zinc-base die-castings in the US has balanced the decline in brass markets, so that the consumption of zinc is maintained and its use in foundries increased. The chart shown below (from *American Metal Market*) illustrates the trend and overall growth in consumption from 400,000 short tons in 1925 to 1,000,000 tons at the present time.



Whilst the annual consumption of lead runs at the rate of 1,000,000 tons, less than 1 per cent. of the newly-mined metal finds its way into brass and bronze foundry alloys. The brass, bronze and bearing-metals of the commonly-recognized foundry products find their supplies from the secondary-metals market. They occupy a small amount of the total for primary lead and therefore exert a minor, but significant, effect upon its welfare. The lead/zinc industry's fight in US Congress to secure additional protection from foreign shipments by raising tariffs through a system of graduated duties appears "dead." Apparently, the Federal agencies have decided against recommending that the President sign the Bill.

Company News

ASSOCIATED COMMERCIAL VEHICLES, LIMITED—Creation of 2,200,000 £1 ordinary shares will be proposed at an extra-ordinary meeting on January 21, 1961. The company, as already stated, is making a rights issue of 2,087,500 £1 shares at 30s. each on a basis of one for every share held on December 28, 1960.

H. W. KEARNS & COMPANY, LIMITED, machine-tool manufacturers, of Altrincham—Orders are coming in freely, there is a lot of business about, and prospects are encouraging, states the chairman, Sir Lionel Kearns. The company is planning a new office block and alterations to the works which will enable production to be increased.

BRUCE PEEBLES & COMPANY, LIMITED, manufacturing electrical engineers, of Edinburgh—Shareholders are informed that delays in the new plant which is still not available will seriously affect the current year's results and it is unlikely that a dividend will be recommended on the ordinary shares, compared with 10 per cent. for 1959.

LANCASHIRE STEEL CORPORATION, LIMITED—Final dividend of 7½ per cent. makes 11 per cent. for the year ended October 1, 1960—an increase of 2½ per cent. over the previous effective rate. Group profits were £4,425,713 for the year, compared with £3,873,440 for the 53-week period of 1958-59, before tax of £2,290,000 (£1,950,000). The profit balance is £2,135,713 (£1,923,440).

WHITEHEAD IRON AND STEEL COMPANY, LIMITED—Group profits, before tax, are up from £924,376 to £1,446,830 for the year to October 1, 1960. The total dividend is raised by 5 per cent. and a one-for-one scrip issue is proposed. After tax of £715,683 (£319,059) the profit balance is up from £605,317 to £713,147. Final dividend is raised from 15 per cent. to 17½ per cent., making 30 (25) per cent. on the existing £1,250,000 capital.

BRITISH OXYGEN COMPANY, LIMITED—Profits for the year ended September 30, 1960, rose from £3,935,579 to £4,426,993, after tax and outside interests. Final dividend of 10 per cent., as forecast, makes 16 (14) per cent. The increase in profit is attributed almost entirely to sales expansion by overseas companies. Greater turnover at home, it is stated, was offset by higher wages and other costs, particularly in the last few months.

REDPATH, BROWN & COMPANY, LIMITED, structural engineers and iron and steel stockholders, of Edinburgh (a subsidiary of Dorman Long & Company, Limited)—After providing £242,719 (£282,823) tax, net profits amounted to £302,806 in the year ended September 30, 1960. The previous year's net balance was £899,154, including £59,466 over-provided tax. An upward trend in output started in the latter part of the year, resulting in some improvement over the previous year's low output, it is stated. The home order-book has improved considerably, and the four works are now adequately committed, but export orders remain much below normal level.

STONE MARINE ENGINEERING COMPANY, LIMITED, of Woolwich Road, Charlton, London, S.E.7, announce that they have taken over the sale of all yellow and whitemetal products previously handled by J. Stone & Co. (Propellers), Limited. Mr. P. A. T. Burrows has been appointed sales representative for these products.

Stewarts and Lloyds' Report

Increase in group profits, before tax, from £11,077,000 for the 1958-59 53 weeks' period to £18,241,000 for the year to October 1, 1960, is reported by Stewarts and Lloyds, Limited, manufacturers of steel tubes, etc., of Glasgow, and the total dividend is being raised by 4 per cent. A final of 12 per cent. makes 15 per cent. on capital increased from £20,000,000 to £27,000,000 by a rights issue, compared with the forecast of at least maintenance of the previous year's 11 per cent.

The profit balance, after heavier tax charges, is up from £5,799,000 to £10,560,000, of which £442,000 (£351,000) is attributable to outside interests. Profits exclude those of the Staveley Iron & Chemical Company, Limited, which did not become a member of the Stewarts and Lloyds group until September 12, 1960. Staveley's net profit, after tax, was £542,200.

Sales to customers expanded from £118,500,000 to £139,400,000. Of the profits before tax, Stewarts and Lloyds contributed £10,479,000 (£5,728,000), home subsidiaries £4,359,000 (£2,517,000), and trade investments and overseas companies £3,403,000 (£2,832,000).

Large Pipeline Orders

The statement says that the steel and tube works were much more fully occupied than in the previous year. Increased exports to the oil industry resulted from certain large pipeline orders the group obtained. Since the end of the financial year, however, trading conditions had become more difficult. Capital expenditure, amounting to £7,101,000, continues on the development programme of the works in the UK, and plans are well advanced for a major scheme of capital development at Corby (Northants), which it will not be possible to finance from internal resources, the directors state.

Representative outputs for the Stewarts and Lloyds UK group, excluding Staveley, for the 1959-60 period (with the 1958-59 figures in parentheses) were:—Pig-iron, 1,922,000 (1,536,000) tons; steel ingots, 1,870,000 (1,414,000) tons; spun-iron pipes and castings, 402,000 (324,000) tons; steel tubes, 1,008,000 (822,000) tons.

Tonnages of steel tubes despatched were:—Home (excluding oil), 533,000 (450,000) tons; oil industry, home, 20,000 (24,000) tons; export, excluding oil, 248,000 (232,000) tons; oil industry, export, 205,000 (127,000) tons; total, 1,006,000 (883,000) tons. Despatches of spun-iron pipes and castings, excluding Staveley, were:—Home, 310,000 (246,000) tons; export, 83,000 (87,000) tons; total 393,000 (333,000) tons.

Viscount Weir Resignations

In order to devote more time to the overall administration of the G. & J. Weir Holdings, Limited, group of companies Viscount Weir is giving up his post on the board of the principal subsidiary, G. & J. Weir, Limited, Glasgow. Mr. J. Russell Lang has been appointed chairman of the company in his place. Lord Weir is also resigning from the boards of Weir-Catton, Limited, and Weir Foundries, Limited.

Mr. J. W. Atwell has been appointed managing director of G. & J. Weir in place of Mr. Lang and Mr. W. K. J. Weir has been appointed an additional director of that company. All the changes take effect from December 31.

MR. HAROLD P. VALENTINE has been elected vice-president, international, of the Yale & Towne Manufacturing Company, Limited. According to reports, this is a newly-created position.

SECTION DEVOTED TO THE TECHNOLOGY OF PRODUCING DIMENSIONALLY-ACCURATE CASTINGS

BICTA Annual Conference

Further Discussion around Papers presented

In the December 1, 1960 issue of the JOURNAL, a report was published of discussions which took place at the first two sessions of the second annual conference of the British Investment Casters' Technical Association held last year. What follows is a similar report relating to the concluding sessions, concerned with papers under the titles: "Experiences with Vacuum Casting into Investment Moulds"; "Industrial Refractory Crucibles," and "Dimensional Aspects of Lost-wax Investment Castings." A notable feature of the discussion was the freedom with which the exchange of ideas and views took place. This change in atmosphere from the position obtaining before the Association was formed was referred to with satisfaction by the chairman in his closing remarks.

At last year's conference in London of the British Investment Casters' Technical Association, eight papers were read and discussed. The early sessions dealt with papers on producing 13 per cent. chromium steel castings, specifications in the investment-casting industry and a film on the multiple-dip process. These first two sessions were under the chairmanship of Mr. L. S. Taylor and Mr. N. Walker respectively. What now follow are reports of discussions on the remaining papers, comprising the third and fourth sessions under the chairmanship of Mr. G. S. Tomkinson and Mr. R. W. N. Danielsen, in turn.

THIRD SESSION

Vacuum Casting

The first paper dealt with in this session was "Experiences with Vacuum Casting Into Investment Moulds,"* by Mr. L. S. Taylor (G. L. Willan, Limited). Mr. G. Lyon (Fairey Aviation, Limited) opened the discussion by saying that all those who had been engaged in making investment castings for highly-stressed parts must at some time have felt that vacuum casting ought to play a great part in the solution of many of their problems and had, no doubt, read what had been done in this field in the United States, Germany, and possibly elsewhere—not forgetting Russian activity. Mr. Taylor had shown that this country was well abreast of others.

The need for vacuum casting would be decided by the character of the casting and the nature of certain alloy-compositions, including very readily-oxidizable metals. In a number of less-essential cases, vacuum casting might also be advantageous. Investment casters using high-tensile alloys were perhaps still making trials in that direction, but in the speaker's view, it had not yet been proved that vacuum melting would result in any significant advance over current practice. If Mr. Taylor wanted to contest that, he hoped he would be able to quote results of tests which were more decisive than others so far reported.

When vacuum-processing, absolute pressure was presumably measured in the tank and the question arose as to whether the pressure in the pores of a mould followed immediately the reducing pressure in the tank, or whether there was some difficulty, or delay, in getting air out of a mould. This might, perhaps, affect the time cycle. Mr. Taylor's paper made it clear that deoxidation practice would still be required with vacuum melting. A point of interest was the appearance of the surface melt; did one see the same amount of slag as was normal or was there a visibly different reaction, he asked. He questioned the reliability of the numerous connections on Mr. Taylor's furnaces and asked about their maintenance.

With regard to relative chemical properties, it was a little difficult to reconcile column three, column one and column two with the reduction in ultimate tensile strength in Table 2. Could Mr. Taylor indicate whether there was any special significance in that or whether it was just a matter of heating. Seeing the rise in impact value, one could only wonder what caused it; there was no marked increase in elongation. What elongation figure would the Author expect to result in column three at a tensile level of 52 to 53 tons?

Air Pressure

Mr. L. S. Taylor, referring to elements that were oxidized, said that at that time, by far the greatest advantage obtained from vacuum casting was the elimination of oxide-films from alloys containing substantial amounts of such elements as titanium or aluminium. As a result of the elimination of the oxide-films, which were normally shown by dye-penetrant methods, vacuum casting was being used for stationary components of engines

* Paper printed in the JOURNAL, October 6, 1960, p. 419.

because of the reduced scrap, quite apart from improvements in their mechanical properties.

As to the advantages to be derived from the vacuum melting of high-alloy steels, he was afraid information was very limited, but an increase in ductility could be expected. Normally, one would look for an increase in ductility with vacuum-melted materials.

On the question of air pressure within the refractory of the mould itself while it was in the vacuum-casting chamber, with a normal melting-cycle, this would depend upon the power available for melting at any given time; normally for a 15-lb. charge, a total processing-time of 15 to 20 min. was considered adequate. Of the 15 to 20 min., possibly 4 or 5 min. were spent in getting the pressure down to one micron. Thus, the mould itself would be subjected to a vacuum system for approximately 15 min., which should allow for a substantial degassing of the mould to take place. Nevertheless, he felt that there was a certain amount of air locked up in the mould material, inasmuch as when ceramic shells were cast in vacuum, finer detail could be reproduced than from a solid mould.

Definitely, the appearance of the metal during vacuum melting was much cleaner. However, if "dirty" bar stock were used, that is, commercial bars, vacuum melting did not necessarily clean it up. In other words, if oxide films were present in the raw material or in the raw-material charge, they were still present after the vacuum cycle. However, provided the necessary steps were taken to start with clean metal, it remained clean throughout the melting cycle—this was most striking when viewing the metal through the observation-window of the plant.

Physical Properties

Reduction in tensile with the same heat-treatment was a characteristic which had been noted. With a vacuum-melted material, as a general rule—and one had to beware of generalizations in this context—the tensile was usually lower for the same heat-treatment and there was a gain in ductility and usually in impact values. Again, insufficient work had been done to ascertain the increase in ductility and impact obtainable at a given tensile level. On balance, there was still a margin of gain.

The figures given in the paper for the 13 per cent. chromium steels had been obtained before the significance of vacuum melting was realized. When the work was repeated, heat-treatments would be adjusted to give tensile strengths comparable with those normally obtained by air melting. Then, figures for elongation and impact properties in material at 50 to 52 tons tensile would be made available.

Replying to a further question on this subject, the Author confirmed that the reduction to 40 or 35 tons tensile resulted from the same heat-treatment as given to the other steels treated.

Melt Size

MR. A. DUNLOP (at that time associated with Wilkins Campbell & Company, Limited) said it should be realized first of all that the Author had dealt with another "tool" for the production of better castings and founders were being forced to use this tool for the newer alloys which were being developed—for example, nickel-base alloys with a high proportion of oxidizable metal. Over the years, acceptable techniques had been built up to produce investment castings based on small individual melts (one melt per mould); a technique which should be carried over into the era of vacuum melting and casting.

A start should be made with good, clean metal, it was not sufficient simply to take any metal and expect to get good results. The development might be as follows:—The steelmaker produced—in batches of 1 ton or 1½ tons in one melt—the vacuum-process bar stock for subsequent remelting in 15- or 20-lb lots in small individual melts, one melt per mould, per furnace. Designs are now well advanced with regard to equipment for individual small melts, but it was necessary that the alloy suppliers should be in a position to supply vacuum-melted alloy bar stock. If events should develop along the lines of the suggested specification already discussed, then one or two tests per ton or half ton of bar stock should release the material for use in small melting and casting units.

MR. TAYLOR, referring to one melt per mould as applied in the investment foundry, said that this had caused much "heartburn" in his works where the principle of one melt, one cast, had been adhered to. His company had been pressed on economic grounds to see if two, three, or four casts per melt could be made and experiments had been carried out on this subject. The furnaces used were not specifically designed for casting investment moulds, but it was found that with certain modifications, to the equipment (in this case with ceramic shells placed on a turntable), three ceramic shells could be cast from one melt of metal, but occasional mishaps occurred and, as a result, one cast for one mould was usually recommended. With regard to the production of bar stock for remelting, it was essential to start with vacuum-melted stock to reap the full benefits from subsequent vacuum melting.

Practical Aspects

MR. A. G. MASON queried two of the Author's statements. First, provided vacuum-melted stock was used as the material for remelting, higher vacuum of the order of microns pressure was not essential to obtain the maximum benefits. Second, Mr. Taylor had asserted that an indirect-arc furnace did not give trouble with respect to carbon pick-up in vacuum. As a result of extensive inquiries among companies engaged in vacuum casting, he had not found unanimous agreement with these views.

MR. TAYLOR emphasized that his comments here were not based on direct experience. A foundry

which (under low-pressure argon) remelted vacuum-melted stock in an indirect-arc furnace could maintain the quality of the vacuum-melted stock on nickel-base alloys containing aluminium, so that it was free from oxide films. With regard to the lack of correlation on the question of carbon pick-up, he could only quote from particular foundries; there had been established a certain "know-how" in the pressure of argon maintained between the electrodes—the selection of argon pressure-range within which to work was critical, but he could not state what pressures were used. Direct experiments had shown that partial pressure and control of the argon pressure also controlled the amount of carbon pick-up which had been overcome.

MR. D. R. WOOD (Mond Nickel Company, Limited) expressed interest in Mr. Taylor's statement that it was essential to use perfectly clean vacuum-melted stock material; it was worthwhile to consider the cleanliness of some of the high-nickel alloys which were of special relevance in this connection. Oxide films had been discussed and it was likely that they consisted of alumina. There were also silicate inclusions, well known in steel melting, which could quite easily arise under ordinary melting conditions. Nitrides could also occur. There was evidence that the two former types of inclusions could be reduced and eliminated by vacuum treatment as described in the paper. The nitride type, however, was very difficult to dissociate as it formed in air and this was a reason why the stock material should be properly vacuum melted.

As far as visual observations were concerned, it was possible to take a dirty nickel-base alloy of nickel-chromium type, remelt it, and observe an increase in cleanliness to the stage where it looked like mercury—obviously a desirable melt to use for pouring a casting. He welcomed Mr. Taylor's further comments on the absolute need for complete purity in this particular regard.

Cleanliness of Melting Stock

MR. TAYLOR endorsed what Mr. Wood had said and added that in producing clean metal, one must pay attention particularly to the quality of the raw material. Exothermic alloy-additions were notorious for adding "non-metallics" to the melt and the cleanest metal, with correct regard being paid to the original source of the raw material, was obtained by vacuum melting and vacuum stock and this stage had been taken as a starting point. With regard to the reference to the treatment of molten metal under reduced pressure or vacuum, he maintained that a noticeable and marked cleaning-up process occurred with air-melted nickel-based alloys which were noticeably dirty, but the resulting material when looked at was not as clean as that obtained by a double-vacuum treatment. In other words, there was a noticeable reduction in oxide films, but they were not eliminated.

Certain nitrides still persisted after high-vacuum treatment. Undoubtedly, nitrides might be broken down, but certain nitrides, e.g., titanium nitride and zirconium nitride, existed also in high-vacuum-melted stock and were not easily dissociated. However, subject to correction, they did not appear to have any deleterious effect on the finished material.

MR. N. MASON asked whether the desirability of remelting stock being vacuum-melted applied if the stock material was rolled from bar with the normal cleanliness of steel prepared in this way.

MR. TAYLOR replied that it depended on the final use of the metal. Most applications, other than nickel-base alloys, which were being referred to, were specific applications where cleanliness was a fundamental consideration and considerable lengths had been gone to to ascertain a suitable melting base free from non-metallic inclusions. What was normally commercially acceptable as wrought bar-stock from a cleanliness point of view would not be accepted as stock for melting for the applications mentioned.

MR. DUNLOP said that in earlier times, it had been noticed on certain high-temperature nickel-base alloys that dirty metal invariably gave a much finer grain-size.

MR. TAYLOR stated that when first starting vacuum casting somebody had said to him, "Look, you're making clean metal, what is going to happen to the grain size?" He had been agreeably surprised because he found, generally speaking, when casting into graphite moulds, the grain size had been much smaller than with equivalent air melting. He would not attempt to say why, this was merely an observation. Regarding the actual pouring of investment moulds, there was not much to choose between them—for the same conditions of mould temperature and casting temperature—but there was some advantage with vacuum casting in employing lower casting-temperatures giving some reduction in grain size. He did not want to over-emphasize this as the differences were marginal, there was a slight advantage, however.

Tensile Loss

MR. A. SCHOFIELD (De Havilland Engine Company, Limited) said he was interested in Mr. Lyon's reference to Table 2 and this loss of tensile of the 13 per cent. chromium steel. At first glance, he thought that this might be due to loss of carbon, as he had found it extremely easy to lose carbon when melting steel in a vacuum furnace. His particular vacuum furnace was of the induction type and the crucible which he used for the purpose might not have been the best choice. As he found it difficult to accept that vacuum melting reduced the ultimate strength of the material, he asked if this matter could be enlarged upon.

MR. TAYLOR said that the answer was, that one could get quite an appreciable carbon loss in the production of the vacuum-melted alloys, when starting with raw materials. Since carbon was a most effective de-oxidizer, particularly at high-

vacuum, any oxygen in the raw materials or the crucible lining could result in quite a marked loss in carbon. The figures quoted had been obtained for vacuum-produced stock, subsequently re-melted, and any significant loss of carbon on vacuum-stock subsequently remelted was not normally experienced. Full details of the chemical composition were not available, but he did not expect any significant carbon loss. This posed the question why the so much lower tensile. He suggested that the absence of some element in some particular form, resulted in improvement in impact and ductility and this also would possibly explain the difference in tensile. In other words, perhaps whatever was present in a certain form to give the low impact, would also give higher tensile-strength —but that was a hypothesis only.

Dental Equipment

The CHAIRMAN stated that his company was interested in using 13 per cent. chromium steel for dental equipment. The loss obtained at the time had led them to spend a considerable sum to find the cause. They had had an ingot made of the material, rolled it out into bars, and cleaned it—to make absolutely certain it had been completely free from any injurious elements—and then cast it. There had been a variation from 1 mm. to 10 mm. They had been interested mainly in the impact values on that material and had subjected the metal to the standard treatment, knowing full well that they might get variations; but then, buyers of dental equipment could be offered a good material which was in demand at that time.

Written Contributions

Subsequent to the presentation of the Paper, the following four questions were put in writing to Mr. Taylor by Mr. L. W. Duffin and Mr. D. C. Jarman (De Havilland Engine Company, Limited).

(1) On page five the Author had referred to the small effect of casting temperature on the fluidity of the casting. Was it not a fact that the fluidity of an alloy of a given approximate composition was directly proportional only to the degree of superheat? It was agreed that the effect of superheat on filling a mould at very low casting pressure was smaller than the effect of an equal increase in mould temperature.

(2) Would the Author expand his views on the relationships between the gas content of the metal as affected by refining pressure, temperature and time; casting pressure; and porosity in the casting. There was little doubt that with a given gating-system and refining-cycle the density of the casting decreased with decreasing casting pressure, as well as decreasing casting temperature. It had been found that a useful technique in preventing porosity was to cast at a higher—sometimes much higher—pressure of inert-gas than the refining pressure.

(3) What extent of grain refinement had been achieved by cold ceramic-shells or by additions to the precoating? Success had not been achieved in refining more than a surface layer of the casting by these techniques, the thickness of the refined layer depending, other things being equal, on the thermal-conductivity of the alloy concerned.

(4) What had been the mould temperature and section thickness and length of the castings which had been filled with only 15 to 20 deg. C. of superheat?

Mr. L. S. Taylor replied *seriatim* as follows:—

(1) The point to be emphasised was the far greater effect of casting speed and vacuum, during casting, compared with casting temperature. A much wider latitude of casting temperature was permissible than was possible with the speed of pouring, and the vacuum, at the time of casting. Certain thin-sectioned turbine-blade castings had only been successfully cast when the casting time had been reduced to less than one sec. and the vacuum during casting had been of the order of one micron. If the casting time had been allowed to extend to two sec. or more, and/or, the pressure during casting had been lifted to two cm., then misruns had occurred. Varying mould and metal temperatures had had a relatively minor effect on the running of these sections. Both mould- and casting-temperatures affect quite strongly the grain-shape and size, which must be taken into account when fixing casting conditions.

(2) The effect of refining-pressures, temperature and time on the gas-content of vacuum-investment castings, was difficult to answer but gas porosity had never been experienced in vacuum-castings other than those arising from mould-reactions and the special defect mentioned on page seven of the Paper. Gas contents of 0.003 per cent. oxygen and 0.005 per cent. nitrogen were normal reproducible values for vacuum-melted stainless-steels. Hydrogen contents had not been determined. These figures were obtained after superheating to 1,620 deg. C. for 10 min. at a pressure of one micron and slow cooling back to the casting temperature. The crucibles were usually of the alumina-type bonded with ethyl-silicate. Lower oxygen figures could be obtained by employing special techniques but these were not normally applied to vacuum-castings. Holding nickel-base melts, containing titanium and aluminium, at 1,620 deg. C. at one micron, allows a further gassing-reaction to occur which was believed to be the removal of nitrogen This reaction could be quite marked and might continue for three min. With reference to shrinkage porosity, it was agreed that castings made and cooled in high-vacuum were susceptible to increased shrinkage-porosity. This effect was aggravated with decreasing metal-temperature, the lower the metal temperature the more general the interdendritic porosity became. A straightforward remedy had been to increase the chamber-pressure immediately after casting, either admitting air, or argon. The technique of admitting an inert gas before casting was not encouraged since this reduces the ability to run thin sections as mentioned above.

(3) Grain-refinement from precoating-additives

and the use of cold ceramic-shells was restricted to the surface layers and was usually confined to within $\frac{1}{8}$- to $\frac{3}{16}$-in. from the casting surface. The cold ceramic-shell had had a greater effect than the precoating additives in reducing the grain size, but it was usual to employ the combination of mould temperature, casting temperature, and precoating additives. A marked difference had been observed in the degree of grain-refinement between competing alloys of the nickel-base creep-resistant type.

(4) The mould temperature had been 1,000 deg. C. and the blade was 2 in. long by $\frac{1}{8}$ in. wide. The thickest section of the blade had been $\frac{5}{32}$ in. with a 0.010-in rad. at the trailing edge.

(This concluded the discussion on this section.)

Crucible Life

After Dr. F. W. Haywood had presented the paper on "Industrial Refractory Crucibles,"* the chairman invited Mr. Gwynn (P.I. Castings (Altrincham), Limited) to open the discussion.

MR. I. L. GWYNN said that to him, the paper offered an unspoken challenge to the user, because it seemed to suggest that, as between one user and the next, there was a considerable diversity in the number of melts which could be made from one crucible of any one type. He was referring here to the figures given in Table 5. Naturally, these were bound to be tied up with variables, such as the materials which were being melted, and the melting conditions, but he suggested that perhaps a more significant factor was the way the crucible was used immediately before the melting commences. It had been found in his foundry that crucibles could vary in life very considerably by applying some very low-temperature treatment to the crucible, possibly packing it on top of preheating furnaces. Over a period of weeks or months, by adopting this technique, the service life had been increased from an average of about 5 to 7, to an average of 10 to 14 melts. That was very significant. He suggested that Dr. Haywood, and Mr. George,† might like to look into this aspect, and possibly give some indication why there was this considerable variation in the number of melts per crucible.

Dr. Haywood replied, by saying that the life figures, given in the paper, had been provided by members of BICTA. However, he gave one or two examples from his own experience. Every attempt had been made to standardize the manufacture of the crucible—even to sending them out suitably packed in standardized-containers. Four or five years ago, his colleague, who helped with the paper, had had occasion to visit a customer who had inquired, "Why don't these crucibles last longer?" He had found that one container had been situated under a tree, and absolutely saturated. There was nothing that could be done about storing the crucibles when they were on the customer's site, but it was thought that if the rain had to soak the straw in which they were packed, at least it should be prevented from getting to the crucibles, so it was decided to pack every crucible in a polythene bag, in an attempt to seal it.

With regard to the question raised by Mr. Gwynn, about pre-heating, there was nothing that could be done because after kilning has taken place, the crucibles have a very low water-content.

After full inspection, and grinding of the top-face, they are then placed in polythene bags and despatched. He then noted, with satisfaction, that the pre-heating, which most of the audience would be carrying out, prior to the first melting, had increased their life from 5 to 7, to 10 to 14 melts.

MR. M. RIDDIHOUGH (Deloro Stellite, Limited) stated that in manufacturing flux-coated welding-rods it had been found that even further precautions had to be taken when packing the welding-rods, and during the time they were kept in store. They had to be kept hot all the time they were in store, until packed, and were not allowed to cool down unless sealed in airtight-containers. If the welding-rods cooled down overnight in the damp British atmosphere, they picked up moisture.

MR. L. S. TAYLOR expressed satisfaction with the life of the crucible in vacuum-melting, and asked whether the fact that vacuum-melting inevitably removed all the water-vapour from the crucible, played a significant part in the long lives of crucibles being experienced in-vacuum. He suggested that Dr. Haywood might feel it worthwhile to heat his crucibles in-vacuum, before packing them in polythene bags.

DR. HAYWOOD expressed gratitude for the helpful comments made by members and his agreement with Mr. Taylor's point with regard to the use of such crucibles in-vacuum. However, two points arose here; first, the removal of water-vapour, which would be very effective; and second, the statement about the packing of crucibles which was very important.

In reply to a question put by MR. H. J. MEERKAMP VAN EMBDEN (N.V. Philips' Gloeilampenfabrieken) regarding the efficiency of sealants, DR. HAYWOOD said that there was no attempt whatsoever to achieve a vacuum-tight container. The ordinary polythene bags were developed, initially, to keep out the rain in certain cases, and was the best thing that could be done prior to despatching crucibles.

Carbon Loss

MR. SCHOFIELD said that when the first vacuum-furnace had been made they had also learnt how to make crucibles, and how to fire them in it. This had led, however, to some considerable trouble from refractory inclusions in their products, and, as it was realized that crucible manufacture was not their speciality, they started purchasing crucibles, which had been highly satisfactory. The speaker went on to say that he had a strong belief that the lack of tensile-strength of a certain material, was due to loss of carbon. If the mould was well

* Paper printed in the JOURNAL, July 7, 1960, p. 15.
† Co-author of the paper.

enough prepared it would contain sufficient oxygen to reduce the carbon content; the question then arose as to whether it came from the crucible. He was thinking not of moisture in the crucible, but of a possible refractory/metal reaction, as the materials of the crucible were often oxides, and they might react with the carbon in the steel-melt.

DR. HAYWOOD considered it very unlikely on general metallurgical grounds, that there would be any material effect on carbon-reduction due to the crucible material. In reply to a further question from Mr. van Embden on the exact nature of crucible failure, Dr. Haywood said that this depended very largely on the particular process used. Most of the questions seemed to have been directed at the high-frequency induction-melting crucible, which had a much shorter life under air-melting conditions, than the crucible used in the arc-furnace. The latter failed as a result of erosion and slagging, whereas, on the basis of the number of failed high-frequency induction-melting crucibles he had had experience of, failure was due, in his opinion, to cracking—generally the manufacturers' fault.

FOURTH SESSION

Mr. R. W. N. Danielsen (Deritend Precision Castings, Limited) occupied the chair for the fourth technical session when a paper was read and discussed on the subject "Dimensional Aspects of Lost-wax Investment Castings"* by Mr. N. Mason (Firth Vickers Stainless Steels, Limited).

Distortion

MR. A. F. EYRES (B.S.A. Company, Limited) opened the discussion by saying that one problem which had not been mentioned in the paper concerned the ovality of round sections, particularly when cored. This problem was not always present in the wax model, although it could occur if the model distorted, or it might occur only in the casting. Another, and frequently encountered, difficulty resulted from flatness and distortion. This was by no means uncommon; moreover, it was very difficult to anticipate, and even when anticipated, it was difficult to assess its degree, because so much would depend on length, thickness, variation of mass etc.—all of which made it difficult to quote a tolerance at all in this respect. Usually, one had to be a little vague on this point, when advising a customer of the possibility of these difficulties arising, until sample castings had been produced, and the degree of distortion revealed.

Another difficulty, which was occasionally encountered, was "dishing" on large flat surfaces of moderate thickness, say ¼-in., even though the wax model might be corrected with the aid of wax denseners or chills.

He was not aware of how many U.K. foundries were able to produce, store and assemble waxes under controlled-temperature conditions. His company had found that waxes swell, and lift away from the wax densener, with increases in temperature. The same problem also arose in the primary investment; if this was not carried out under controlled-conditions of temperature and humidity, the refractory coating lifted from the wax models.

Another difficulty that could arise was heavy scale-formation during heat-treatment, particularly of the carbon-steels. When this scale was removed by shot-blast it could be found that certain dimensions had been lost, particularly if they had been on the lower-range of tolerance to commence with.

The method of ejection of waxes from the die needed careful attention to avoid excessive pressure on any on section—which again could give distortion.

The varying contractions of different types of steels, could occasionally cause problems, if one were asked to produce the same component from two different types of steel, using the same die-equipment. It had been found that the castings produced had not been identical in the different steels.

In order to produce a casting as economically as possible, the aim was to obtain as many as possible, on the same sprue. However, with castings of moderate-size and weight, say, of ¼lb. upwards, marked variations had been noticed between castings at the bottom, and at the top of the sprue; these had been due to differences in pressure from the head of metal, according to the distance from the ingate. There were, unfortunately, no easy answers to any of these problems which could arise with any casting. However, customers should be advised what was a reasonable expectation from investment-casting, in terms of dimensional-accuracy. It had been frequently found that only certain dimensions which were called for on a design-drawing were, in fact, critical. Tolerances on other dimensions could often be increased, by agreement, without causing difficulty to the customer, thus helping to keep the rejection-rate down, and, as a direct result of this, keep down the overall-cost of the casting. There was a great tendency for drawings to be sent to foundries, when asking for a quotation, which were, in fact, machining drawings, where tolerances of ±.002 in. were called for, because such limits present no particular machining problem.

Mr. Mason had mentioned in his paper the difficulty of maintaining closely tied-up dimensions for hole-centres; closely related to this problem was the difficulty of maintaining dimensions on big-circle diameters, where there were a number of holes on a comparatively-large flat surface which, again, might well be subject to distortion. It had been found that customers tended to be irritated when a drawing marked-up with a proposed form-of-supply was returned to them, and there were so many modifications and deletions, that, at first glance, it appeared to bear little resemblance to the original. There was, however, no alternative to this procedure until

* Paper printed in the JOURNAL, June 2, 1960, p. 696.

designers and project engineers were made familiar with the possibilities—and also the limitations—of the process. Extensive marking-up of drawings was universally disliked, but it was essential that customers should clearly understand what they were going to receive, and for founders to indicate clearly the additional operations that would be necessary, to enable them to produce the finished component. If this understanding were reached at the beginning, it would help to eliminate subsequent misunderstandings.

Finishing and Rectification

Mr. Eyres then turned his attention to finishing-operations, excluding machine-shop operations, which should be known, beforehand. When estimating for castings to be produced to the generally-claimed tolerances of ±.005 in., per in., fettling times generally covered the removal of the feeder-heads and generally cleaning-up, and were usually regarded as hand-operations, not requiring particularly close-limits. When, however, it was found that casting—and dimensional—variations had occurred, outside the permissible tolerances, it was necessary to correct them by hand-grinding, possibly involving the use of gap-gauges. Where such an operation had not been anticipated and, therefore, not included in the estimate, costs could go very much awry. Labour costs were the major factor in the cost of investment castings, and the additional cost of rectification could sometimes be out of all proportion to the estimated cost of fettling, and made the quoted-selling-price uneconomic. This problem which had beset the industry for a long time, *i.e.*, whether it was worth while to attempt to rectify castings, as opposed to scrapping them. The answer clearly depended upon the amount of rectification to be done, and the value of the casting in question. Closely related to this point was the question of trying to rectify castings which were either not flat, or had distorted. Again this work could be very costly, because the variations and distortion were seldom uniform, and each casting needed to be dealt with individually. It was a slow process, and usually involved much time from a comparatively skilled operator, who could be employed to better advantage in passing through, in the same period, a larger volume, and value, of castings.

MR. MASON said in reply, that the question of ovality was, in his opinion, tied up with economics. Most of the round designs were made as investment-castings because the designer happened to desire three webs, or other refinements—otherwise he would turn the component from bar. The mere fact of introducing webs, invariably meant that the shrinkage was not constant and, unless one could afford to make one small casting in a mould, such castings appeared to be fairly round until measured. Referring to one of his lectures—delivered on behalf of BICTA to production engineers—he stated that he had displayed castings on a table; after the lecture, he had been horrified to see one of the audience take a scale out of his pocket, measure a casting, and say in a very loud voice, "But it's an eighth out of round!" In fact, the castings in question had been, he thought, very good samples indeed!

Design Trouble

MR. MEERKAMP VAN EMBDEN said that his company had developed investment-casting activities in the research laboratory, and had made some first-class castings. The problem then arose of persuading their own designers-of-apparatus to use the new type of castings. That had been difficult. First, he had approached the designers personally. They were very polite, but he could see by their expressions that their attitude was, "Here again is an interfering busybody from the lab., who wants to teach us our own business." A younger man who was sent next, seemed to give the designers the impression that he was just from a technical school, and therefore could know little about their work. The solution had been to take an elderly employee—a designer who had been there for about 40 years—and to make him enthusiastic about the new method of castings production. He had gone back to the design-office and, passing from board to board, had, in effect, said, "This component is something you can make better by casting, and you must change the design to suit!" That system had worked very well, and a couple of years afterwards, the firm had called in specialists and set up a production investment-foundry.

The problem was to re-educate the designer in the advantages and requirements of castings design. In machining there was one aim, which was to take away as little material as possible, to keep the cost low. On the other hand, in casting design, the aim was to make the component as light, and as small in section, as possible, consistent with soundness. The worst trouble arose when the designers asked them to produce a casting, to the same tolerances and specifications, as the machined components. Then it was certain that they would not succeed.

When making the first dip there was always trouble with small air bubbles, which gave ripples on the surface. This had been overcome, to a great extent, at the speaker's company by using a vibrating plate in the dip-coat solution, during the night. The small bubbles came to the surface and a much better coating on the wax model was achieved.

Two Suggestions

Continuing his remarks, Mr. van Embden referred to another matter, not directly concerned with investment-castings, because it had proved to be very useful, when making microscopic slides of the material. The normal practice was to grind the sample with several grain-sizes, and after changing each grain, to wash out the sample, to get rid of the last grains of coarser material, before switching over to the finer material. For this purpose, it had been found most useful to have ultrasonic-cleaning equipment. He advised the

audience to try this procedure, assuring them that they would be enthusiastic about it.

Two means of overcoming part of the difficulty connected with dimension tolerances, had been found: first, the injection-temperature should be made as accurate as possible—tolerances of 2 to 3 deg. should be avoided and an attempt made to get within half a degree, because then the interference of the wax bubbles would be smaller. After ejection of the wax model from the mould, a little straightening between plates may be carried out by hand, but when cooling down, on a hot day, distortion can occur once more. Therefore, second, the moulds should be insulated by putting them in a small container, filled to a depth of about 4-in. of water, where they float without further distortion. They can then be transported to the end of the line, and taken out. This is followed by cooling-down and hardening—even while brittle—and cleaning. Such a procedure works very well.

MR. MASON gave it, as the conclusion of his foundry, that progress would not be made until every designer was a precision foundryman, and possibly every precision foundryman, a designer. In the meantime, the best had to be done to educate the designers. He understood that two large-scale buyers of precision-castings employed a foundryman—though not an investment foundryman—to advise their design-staff on methods of manufacture, and how to secure economies.

MR. EYRES said that on the leaflet issued by the American Investment Casting Institute, he had been surprised to notice that two tolerances were quoted, one presumably being "as-cast," and the other the F.I.R.* tolerances—presumably, after some accurate fettling. He was surprised that friends in the United States should be able to sell castings with tolerances as wide as were quoted for the as-cast condition. Did this mean, he asked, that all the castings which were sold were finished closely-fettled; also, to what degree of accuracy were they normally fettled, and by what methods. In addition, was it hand, or machine fettling?

Foundry and Customer

MR. C. H. WATTS (Precision Metalsmiths Inc.) stated that the experiences on dimensional tolerances described in this interesting paper paralleled American experiences very closely. A considerable amount of work had been done in examining dimensional tolerances; on a test specimen approximately 3-in. long and 1-in. wide and perhaps ¼-in. thick, this rectangular section, when gated in a horizontal plane, as opposed to a vertical plane, exhibited considerable differences in dimensional variation on a 3-in. length. He wondered whether anything similar had been experienced in British tests. A comparison of test data, in that respect, would be interesting. Some of the terms were a little strange, he said, and added that this question of dimensional-tolerances depended in many instances, on the relationship between the foundry, and the customer. If the latter required a tight-dimension, then many foundries would machine-finish on a particularly tight-dimension; and, if this were not required for a particular application, then there might be some gate-stub that was left—perhaps because the customer himself was going to machine that surface, and it was not required to finish it completely, in that instance. It was hard for him to give either a general, or a specific, indication; again, it more or less depended on the relationship between the foundry and the customer. They endeavoured in every instance to work as closely as possible with the customer. It was not desirable to give him more than he needed because that raised the price, and if he could use a casting with some of the gate-stub left—well, then it was preferable to leave castings in this condition.

MR. L. E. CARR (Precision Metalsmiths Inc.) said that the dimensions mentioned in the handbook of the Investment Casting Institute, were the dimensions which the various associated foundries could hold-to. The "as-cast" dimensions, as noted in the book, were those despatched in the "as-cast" condition. Mr. Watts had answered questions as to whether customers would accept them. The F.I.R. tolerances were held-to, and called-upon. It was stated, in their book, that those particular dimensions cost extra; any straightening and finishing operations, had to be paid for. His question, how many of the audience had seen the latest issue of the handbook, received a show of hands. He then continued, by saying that he considered that it might be worth while to work through Mr. Bolton, and perhaps arrange a course, on the basis of this book. This might give founders an idea how to approach more directly some of their particular problems on dimensions.

MR. EYRES agreed that, generally speaking, this answered his question, but added that the "as-cast" tolerances, however, seemed to be much larger than would normally be considered acceptable in this country.

MR. CARR replied that no matter what controls were exercised there would still not be sufficient controls, on a production basis, to get 100 per cent. delivery with such tight tolerances. If the customers wanted these close tolerances, they can be given what they want, provided they would go a step further, and pay extra.

Specification Book

MR. WATTS said that they were experiencing difficulties in setting-out some of their specifications in the form of a book, such as the ICI manual, and he wished to say that this had been a group effort, in which all foundries participated, and that the dimensional tolerance had been agreed upon, so that it could be generally held. It was probably broader than many of them adhered to, but rather than make it something really tight

* F.I.R. is understood to mean, full indicator reading, similar to the term, total indicator reading, used in the UK.

when, perhaps one, or two, of the foundries would think that they could not possibly hold it, they would not issue a book to limit them. This was probably the reason why the tolerances seemed as broad as they did. He was sure, there were many foundries which could, perhaps, do better.

Mr. Carr added that the shape of the part, its size, and the alloy, affect the tolerances. A very simple shape, a small part, could be cast and held very closely to size. But if a large—say a 26-in. part with coring, slots and holes—were taken, nobody could cast to the tolerances referred to in the book.

MR. G. LYON (Fairey Aviation, Limited) stated that his foundry had encountered a wide variation in customer reaction to this question of tolerances, owing to the varying degree of understanding of the factors which made tolerances necessary. This was part of the task of educating customers.

Mr. Mason seemed to favour casting-drawings made by the customer. He was not so sure that it was not better for the founder to reply to the customer, with his own version of the drawing. Possibly, different customers responded in different ways. They had had experience of it both ways with their customers, and their own machine-shops. It was not only a question of producing the casting with a given dimensional variation, but a location for jigging was an important factor, which was often lost sight of. There had been cases in which the customer had found it more satisfactory to be given a location for jigging, which resulted in the important dimensions being maintained, even at the risk of the additional operation of taking the location off. When producing large numbers of castings—say 13-in. long—and applying the factor of ±0.005 of an in. per in. variations of over ±1/8 in. would result, and special precautions had had to be taken to improve on that.

Casting Drawings

MR. MASON said that with regard to casting drawings, they were perhaps too idealistic in thinking that the customer would be sufficiently aware of the problems to be able to produce casting drawings. He did not think that day would be reached for a very long time, but, in the meantime, his company invariably made casting drawings for components, and usually returned them with quotations, and acknowledgments of orders to show the customer what he would receive. Generally speaking, it was far better at that stage to have the fight, if there was going to be any argument at all, as to what could be produced, rather than when a few thousand castings had been produced and were on the way back.

Certain customers often said "Well, such-and-such a foundry had offered to do it to such-and-such a dimension," they quoted a figure which one, in one's wildest dreams, would not even dare consider. It was his firm belief that this sometimes was just a "try-on." However, other founders took the attitude, "Well, I've not mentioned it, but I'll grind that to size and shotblast it, and no one will ever know the difference." Some honest common-ground was needed on these matters.

A statement had been made to the effect that, unless a precision foundry were prepared to carry out finish-machining and grinding, there would, in future, be little scrope for the precision foundry that only wanted to produce castings. Such a conception would obviously alter the whole position of the precision foundry as we know it.

MR. BRIGG asked whether it mattered to the customer precisely how products were achieved, so long as they were produced. He was not so convinced that the product quoted for was always produced, and if a customer were really determined in his mind that a part was rejectable, he could reject it. The only way of coping with this problem was unequivocal liaison between founder and customer.

Written Contributions

The following two questions were put to Mr. Mason by Mr. L. W. Duffin and Mr. D. C. Jarman:

(1) Had the Authors considered the effect of firing-time and temperature on the shrinkage of the mould? With the normal sodium-silicate bonded Austenal-type mould, as with most unfired ceramic-bodies there was a contraction above about 800 deg. C., which increased progressively with time and temperature. This was, of course, due to the gradual formation of the ceramic-bond, on which the fired-strength of the mould depended. To overcome this effect, would the Authors recommend a constant firing-cycle, or a cycle sufficiently long, at any one temperature, to achieve equilibrium at that temperature?

(2) Had the Authors found it necessary to allow a variable factor, for the shrinkage of the casting, from the molten-state, to room-temperature, depending on the alloy used. It was the writers' experience that the 18/8 and the 13 per cent. chromium-steels required considerably different shrinkage-allowances presumably due to the difference in thermal-expansion.

Mr. N. Mason replied *seriatim* as follows:—

(1) The problem of varying shrinkage of the mould, caused by the firing-cycle, was considered at great length, in the early stages. The development of true ceramic-bonds naturally affected the strength of the mould when casting, and, as such, had a definite influence on the crushability of the investment, and subsequent danger of "tears." The optimum fired-strength was the weakest-mould obtainable, consistent with its ability to be handled, until the casting had cooled. This could only be reproduced by a fixed-percentage of bond, fired under consistent-cycle conditions, preferably long enough to achieve equilibrium. Once these factors had been determined, it was his opinion that they should be rigidly adhered to, in order to minimize any variation of dimension.

(2) His experience had not shown any necessity to vary the shrinkage factor from one alloy to another. Specifically dealing with the 18/8 and 13 per cent. chromium alloys, it was standard

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sand-foundry practice to utilize the same contraction allowances. It was agreed that theoretically it would seem necessary to make some allowance, but in conjunction with the difference in thermal expansion, could also be considered the effect of casting-temperatures varying above the liquidus temperature, which in itself, could cause differential shrinkage.

Closing Remarks

The chairman in closing the Conference, said that his quick impression had been that the "ice" had well and truly been broken. Four years ago it had been pretty thick, but on this occasion one sensed a greater freedom of discussion and much happier, friendlier, discourse at the various social functions. Next, he acknowledged the help given by the FOUNDRY TRADE JOURNAL in publishing the previous Conference proceedings.

In his concluding remarks he said he hoped the visitors had enjoyed the Conference as much as they had enjoyed having them. In particular, he appreciated Mr. Carr's remarks and the greetings he conveyed from the Investment Castings Institute of America.

Having expressed his gratitude to his colleagues on the Council, and to Mr. J. Bolton for all the administrative arrangements, he declared the Conference officially closed and the new chairman (Mr. Danielsen) in office.

The British Investment Casters' Association announce that at an extraordinary general meeting held in November last, MR. E. G. DONALDSON, B.SC., A.I.M., was appointed as secretary of the Association. (He succeeds MR. JOHN BOLTON who on October 1 took up the position of director and secretary of the British Steel Founders' Association.) Mr. Donaldson was previously on the staff of the International Mechanite Metal Company, Limited.

News in Brief

THE ORIGINAL SOCIAL CENTRE built for Newton Chambers and Company, Limited, at Chapeltown in 1865, was re-opened as the Lane End Workingmen's Club last month. Club members had bought and renovated the premises.

MR. J. V. ISAACS, past-president of the Yorkshire branch of the Contractors Mechanical Plant Engineers was the chief guest at the first dinner/dance of the Derbyshire branch held at Chesterfield, when there were 230 present.

BRITISH RAILWAYS carried 14,500,000 tons more freight during the first 47 weeks of 1960 than during the same period of 1959. The increased carryings are made up of 2,400,000 tons of general merchandise, 7,700,000 tons of minerals and 4,400,000 tons of coal and coke.

AN ORDER received by Lithgow's, Limited, Port Glasgow, is for a 5,330-ton banana boat for Jamaica Banana Products which will cost almost £1,000,000. The vessel will have Sulzer diesel engines—instead of turbines—made by David Rowan & Company, Limited, Glasgow.

BARNSLEY INDUSTRIES have been invited to take part, with the Chamber of Commerce, in the celebrations of Commonwealth Technical Training Week in the town this year, beginning on May 29. A technical exhibition will be held at an open week at Barnsley College of Technology.

THE FIRST EXPORT ORDER for a new Ossett product—a mechanical dumper—has been completed by Northfield Industrial Fabrications, Limited, engineers, Park Works, Northfield Road, Ossett. Two dumpers, together worth between £8,000 and £9,000, are going to a Swedish company.

IN SOME PARTS of the foundry units of the Osborn Group, Sheffield, overtime has been eliminated and short-time working introduced. The steps are stated to have been taken to offset temporary recession in some classes of work. In one foundry about 50 men are affected. They will alternate with a three-day week.

MR. W. H. HIGGINBOTHAM, chairman of Edgar Allen and Company, Limited, Sheffield, presented awards to 23 employees with 25 years' service and to three with 50 years on December 21. The 50-year-service men were Mr. Harry Baines, a melter in the electric-furnace department, who is retiring, Mr. Harry Booth and Mr. Will Hague.

MR. T. S. SHIPMAN, managing director, Jones and Shipman, Limited, machine-tool manufacturers, Leicester, announced last month a personal gift of five-shilling shares to more than 400 workers and retired workers of the company. The number of shares each worker will receive will depend on the length of service over 10 years.

A PROTOCOL on technical aid to Bulgaria in the building and expansion of industrial and power-generating plant was signed in Moscow on December 1. In accordance with this protocol, the USSR will also give Bulgaria technical assistance in the expansion of the Lenin Iron and Steel Mill, the Maritsa-East Thermal Power Station, an oil refinery in Burgas, and the Damayanov Copper Smelting Works.

G. & J. WEIR (HOLDINGS) LIMITED, Glasgow, announce that a subsidiary company, Weir Valves, Limited, has made an issue of shares to Pacific Valves Inc., of Long Beach, California. Weir Valves will manufacture and market Pacific Valves' products throughout the world except the US. The company, which will continue to be controlled by G. & J. Weir Holdings, has changed its name to Weir-Pacific Valves, Limited.

AT THE FOURTEENTH annual distribution of awards of Samuel Osborn & Company, Limited, last month, the award for the outstanding apprentice of the year was gained by Michael Grayson of the Wicker Works, who received a £10 prize. Nineteen-year-old Miss Jean Booth, at present in the drawing office, received a special award for gaining five passes in an engineering examination. One hundred and seventy apprentices attended.

AFTER ONE of its most successful trading years Leyland Motors, Limited, Lancs, is still showing an upward curve in orders received, particularly from overseas. During the last four months, the group, including Albion and Scammell, have been receiving vehicle orders at a value of well over £1,000,000 per week. Sales during this period are 18 per cent. higher than last year for the quantity produced vehicles of Leyland and Albion.

INVESTIGATIONS on electro-polishing of stainless steels, particularly of nickel-free austenitic Cr/Mn/N stainless steels at the National Metallurgical Laboratory,

India, have revealed that sulphuric acid can be used to replace the phosphoric acid required in the electrolytic bath. While mechanical polishing involves time-consuming grinding and buffing treatments, the electrolytic technique yields a mirror-like lustrous finish at a much lower cost, it is stated.

SHEFFIELD'S TALLEST CHIMNEY, that at the Wicker works of Samuel Osborn & Company, Limited, is soon to be dismantled, as it is no longer needed with the changeover of the drive of the forging hammers from steam to compressed air. The chimney, octagonal in shape, and originally 191 ft. above ground level, was put up in 1853 in 12 weeks at a cost of £320 by the Sheffield steeplejacks, Harrisons. Its present height is 184 ft. 5 in. above ground.

THE WAGES OF LABORATORY ASSISTANTS and freedom of employees of the Park Foundry, Belper, Derbyshire, to be members of trade unions, is to be the subject of direct discussions between the firm and the Association of Scientific Workers. A statement by the Industrial Court said that after submissions had been made by both sides following a complaint by the Midlands regional organizer of the union, it was recognized that there had possibly been misunderstandings.

GIFTS TO THE UNIVERSITY OF LEEDS include £1,375 for the Department of Mechanical Engineering, from the Department of Scientific and Industrial Research, for research on elasto-hydrodynamic problems; £3,850 for the Department of Metallurgy, from the United Kingdom Atomic Energy Authority, for research on pure and commercial uranium; and £1,000 for the Department of Mining from Richard Sutcliffe, Limited, manufacturers of mechanical-handling equipment, of Horbury.

THE WALMSLEY (BURY) GROUP, LIMITED, plan to close four foundries which they operate—three in Bury and one in Wigan—when their new foundry, at present being constructed in Crompton Way, Bolton, is completed. Primarily designed as a foundry, the new building will have accommodation for ancillary processes, including patternmaking and machining and glazing of cylinders. Two former cotton mills adjacent to the new site have been acquired and these will be used for pattern storage and for patternmaking purposes.

CHANGEOVER TO DIESEL LOCOMOTIVES at the Grimesthorpe Locomotive Depôt at Sheffield will start early this year. The locomotives are scheduled to be delivered at the rate of three a week until the total fleet of 67 has been delivered. The diesel fleet will eventually consist of 46 locomotives of 1,365 h.p. each, and 21 of 1,000 h.p.; they will be used for the freight services for which Grimesthorpe is responsible. This is the first step in the implementation of British Railways proposals for Sheffield under the White Paper plan. Two of the new type locomotives have been at the depôt for training purposes for some time.

AS A DIRECT RESULT of the recent acquisition by Miles Druce & Company, Limited, of the whole of the issued share capital of Douglas Elliot & Company, Limited, steel stockholders, Leeds, the name of the latter company is being changed to Douglas Elliot Steel, Limited, which falls into line with other members of the group. A separate company is also being formed, wholly owned by Miles Druce & Company, Limited, to be called Douglas Elliot Pig Iron Limited, acting as pig-iron distributors and representing Barrow Ironworks, Limited, for their hematite and semi-phosphoric pig irons. Both these changes took effect from January 1, 1961.

Personal

Mr. W. GRAY has been co-opted a director of A. Reyrolle & Company, Limited.

Mr. J. G. STEWART has been appointed a director of Stewarts and Lloyds, Limited.

Mr. M. I. PRICHARD has resigned his directorship of Massey-Ferguson (United Kingdom), Limited.

Mr. WILFRED E. NIXON has joined the board of Foundry Equipment and L. & Y. Holdings, Limited.

THE IMPENDING RETIREMENT (on April 30, 1961) is announced of Col. S. C. Guillan, for 50 years secretary of the Institute of Metals.

Mr. T. E. H. BIRLEY, deputy overseas manager of British Insulated Callender's Cables, Limited, has retired after 40 years with the company.

Mr. C. C. MILLER has been appointed deputy chairman, Earle Bourne & Company, Limited, brass rollers and tube makers, Heath Street South, Birmingham 8.

Lieutenant-Commander G. W. WELLS, managing director (production), United Steel Companies, Limited, Sheffield, is on a two-months' business trip to Australia.

Mr. G. E. LOWE (chief engineer) and Mr. A. R. RUMFIT (technical sales manager), have been appointed special directors of the Yorkshire Switchgear Engineering Company, Limited, Leeds.

Sir JOHN WRIGHTSON has accepted an invitation to join the board of A. Reyrolle & Company, Limited. Sir John is chairman and managing director of Head, Wrightson & Company, Limited.

Mr. A. NADIN, general manager of Brayshaw Furnaces, Limited, furnace engineers and of Brayshaw Tools, Limited, both of Belle Vue Works, Manchester, has been appointed a director of both companies.

Mr. ERIC RUSSELL has been appointed joint managing director of Herbert Morris, Limited, with Mr. FRANK MORRIS, chairman of the company. Mr. STANLEY GARDNER has been elected to the board as sales director.

Mr. L. HAMMOND and Mr. F. V. MILLS have been appointed directors of Christy & Norris, Limited, iron and brass founders and manufacturing engineers, Chelmsford, Essex. The company is a subsidiary of Christy Bros., Limited.

Major General Sir CHARLES DUNPHIE has been appointed deputy chairman of Vickers, Limited, as from January 1. He will retain his present posts of the chairman of Vickers-Armstrongs companies and managing director of Vickers.

Mr. R. B. PINKNEY, managing director, has been appointed chairman of Caird & Rayner, Limited, marine engineers, London, in succession to Mr. G. F. R. BAGULEY, who has retired from that post but will continue as managing director.

Mr. J. D. SILK (commercial manager) Mr. J. D. HULLOCK (general foundries manager), and Mr. H. O. W. HILEY (secretary) have been appointed additional directors of Clay Cross (Iron & Foundries), Limited, and will retain their present positions.

Wild-Barfield Electric Furnaces, Limited, announce the following promotions:—Mr. W. R. BREW to be executive manager (engineering); Mr. F. L. GLADWIN, executive manager (commercial); Mr. O. V. METCALFE, executive manager (production), and Mr. R. C. RAY to be sales manager.

F. J. Ballard & Company, Limited, industrial oven manufacturers, announce that Mr. G. N. TURNER,

Personal

who has been with the company 32 years has been appointed assistant technical director in place of Mr. R. J. BROOMER who is resigning from the company after five-and-a-half years' service.

John Summers and Sons, Limited, announce that Mr. J. IVAN SPENS, O.B.E., C.A., has retired from the board, and that Mr. STEPHEN A. R. GRAY and Mr. PETER J. SUMMERS who, for the past four years have been assistant general managers of the Shotton Works, have been appointed directors of the company.

Mr. J. DOUGLAS LATTA, who was recently appointed a director of Glenfield & Kennedy Holdings, Limited, has joined the board and becomes chairman of its subsidiary, Glenfield & Kennedy, Limited. Mr. W. B. TRENHOLME, general works manager at Kilmarnock, has been appointed a director of the subsidiary.

Mr. R. S. BRUCE, president of Sheffield Chamber of Commerce, Dr. C. COCKRAM, production director of the heavy organic chemicals division of Imperial Chemical Industries, Limited, and Mr. G. R. MCKENZIE, managing director of the Carborundum Company, Limited, are among those who have been made Fellows of the Institution of Works Managers.

The Council of the Institute of Metals has elected Professor W. HUME-ROTHERY, Isaac Wolfson Professor of Metallurgy in the University of Oxford, as an honorary member of the institute. The Council has also elected Major C. J. P. BALL, Dr. MAURICE COOK and Lt.-Col. S. C. GUILLAN as fellows, in recognition of the services they have rendered to the Institute.

Mr. C. M. SLOCOMBE has been appointed a director of engineering of Distington Engineering Company, Limited, as from April 1, 1961, and will relinquish his present post of director of engineering at Samuel Fox & Company, Limited, on August 31, 1961. Both companies are subsidiaries of the United Steel Companies, Limited.

Mr. STANLEY ROBERT PARKER, senior lecturer at Enfield College, Middlesex, has been appointed head of the engineering department at Keighley Technical College, in succession to Mr. H. C. TOWN. Aged 38, Mr. Parker has been on the staff of Enfield College since 1945 and will take up his new duties at Keighley early this year.

Mr. J. P. V. WOOLLAM has been appointed deputy chairman of Simon-Carves, Limited. He joined the company in 1916 and was appointed a director in 1945 and a joint managing director in 1953. He is also a director of the holding company Simon Engineering, Limited, and of a number of subsidiary and associated companies.

Mr. J. B. SPENCER has been elected to the board of Lancashire Dynamo & Crypto, Limited, Trafford Park, Manchester. He will be general manager of the company's works at Willesden in succession to the late Mr. C. F. JACKSON. Mr. D. W. MALIN has been appointed a director and general manager at the Trafford Park Works.

Mr. F. MAITLAND WRIGHT and Mr. NORMAN WILSON have been appointed joint managing directors of Josiah Wedgwood & Sons, Limited. Sir JOHN WEDGWOOD has been reappointed as deputy chairman. Mr. JOSIAH WEDGWOOD retired as managing director of the company at the end of last year, but will continue as chairman of the board.

JOHN C. GARRELS, JR., of Springfield, Massachusetts, USA, has been elected to the board and has been appointed to the position of deputy managing director of Monsanto Chemicals, Limited. Mr. Garrels, who has been an assistant general manager of the company's plastics division since 1956, will assume his new responsibilities early this year.

Mr. D. RIDDELL, chief engineer, Mr. D. L. SHAND, works manager, and Mr. A. G. WHY, secretary and accountant, have been appointed directors of Westool, Limited, engineers of Auckland, Co. Durham. Mr. G. R. HOOK has resigned from the board after 41 years with the company, during which he was for many years managing director.

Obituary

The death has occurred of Mr. E. R. FRANCIS, B.SC., who was formerly a member of the staff of the FOUNDRY TRADE JOURNAL and its sister journal the *Iron and Coal Trades Review*. He was born in 1899 and after the 1914 war was on the staff of the Science Museum, South Kensington, relinquishing this post to join the Safety in Mines Research Board. He joined the staff of Industrial Newspapers, Limited, in 1932, where his chief responsibility was the gathering and presentation of information from overseas sources, work which he carried out with both enthusiasm and marked ability. He was an outstanding linguist and a mathematician of no mean order. Whilst he was assistant Editor of the JOURNAL, he presented a paper to the London branch of the Institute of British Foundrymen, in 1942, on "Metallurgical Literature," a monumental contribution on how to use the material available.

After a short period with the Institution of Electrical Engineers, Mr. Francis joined the staff, in January, 1946, of the technical information section of the research and development department of the Mond Nickel Company, Limited, as senior assistant. He became technical information officer in July, 1951, but had to relinquish that appointment in July, 1956, on account of failing health. He died on Christmas Eve.

Mr. W. ARCHDALE, a director of James Archdale & Company, Limited, machine-tool manufacturers, Birmingham and Worcester, has died at the age of 65. His father was the founder of the firm.

The death is announced of Mr. J. MASTERS at his home in Lancing, Sussex, on December 21. He started his career in the foundry as an apprentice at Kitson's of Leeds and went on to Fowler's of Leeds, Carters of Stalybridge and Lowcock's of Shrewsbury. He joined the staff of Fordath Engineering Company, Limited in 1926, where he remained until his retirement in 1946. Mr. Masters was a well-known member of the Lancashire branch of the IBF, joining in 1917. He was branch president and a diploma award winner.

Mr. WILLIAM RYLAND WILLIAMS who was prominently associated with the brass and copper trades in Birmingham for nearly half a century died on the eve of his 83rd birthday. He was for nearly 40 years chairman and joint managing director of the family business of Williams Brothers and Piggott, Limited, of Herbert Road, Small Heath, Birmingham, and was a founder member of the British Non-Ferrous Metals Federation. He died at Kidderminster where he had gone to live with his daughter earlier this year.

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Raw Material Markets

Iron and Steel

With resumption of work at the ironfoundries following the Christmas holiday, business is similar to that of recent weeks. The overall position shows a deterioration, compared with the opening of last year, particularly in the case of the engineering and speciality foundries supplying the motor car industry. At that time demand for castings from this trade was at peak level and maximum outputs were being obtained; recently, however, demand has shown an appreciable fall and there is insufficient work to enable many of these foundries to maintain a full working week. The call for castings for commercial vehicles and tractors is at a good level, however, and foundries supplying high quality castings to machine tool makers, steelworks, power and electrical plant manufacturers, heavy engineering trades, and others are also receiving good support.

The building trades maintain a good demand for castings from the light foundries. Despite a seasonal increase in the sale of domestic utensils the demand for castings from this industry has shown little change. Most of the light foundries are anxious to obtain more work as many of them have highly mechanized plants which are not being engaged anywhere near productive capacity. Most of the jobbing and textile foundries are fairly well engaged, but they also could undertake more work.

The supply of pig-iron in all grades is plentiful, and the foundries have little difficulty in covering their requirements. The low phosphorus irons used in the production of high-duty castings continue to be in heaviest demand, and hematite and refined irons are also delivered to requirements. Plentiful supplies of high phosphorus irons are available for the light, jobbing, textile, and some of the engineering foundries which use this grade, and producers are able to meet home demand without difficulty and also to continue sending consignments overseas.

Arisings of the better grades of cast-iron and steel scrap are readily accepted by the ironfoundries, but available supplies continue restricted and special qualities are scarce. Foundry coke, ganister, limestone, and firebricks are readily obtainable.

The re-rollers started work after the holiday with good order-books. Business on hand is sufficient to enable them to maintain satisfactory outputs, although for some of their products demand is not now so heavy, chiefly because of the recession in the motor car industry. Most of the re-rolling mills have adequate supplies of mild steel semis, as apart from the stocks on hand, home steelworks continue to send forward substantial tonnages in this grade of steel. The supply of carbon and alloy steel billets is not so good, and difficulty is experienced in obtaining the required tonnages.

Non-ferrous Metals

End-year influences in copper have made for a poor market and the price of the red metal has been fluctuating narrowly around £228 a ton. The one feature of interest continues to be the strike position in Chile at the El Teniente mine. As far as can be ascertained the strike was due to begin on Tuesday, but it now seems that it will begin on Monday. El Teniente wants the same terms of settlement obtained by the workers at Chuquicamata who went back to work six weeks ago after a six weeks' strike. Much will depend on the outcome of the Chilean position as the possibility of a strike is a sustaining factor in the market. Meanwhile, stocks of copper in the UK are over 14,000 tons, the highest level reached for 15 months.

In the US the market is also flat, although there has been a modest increase in activity following the reduction in the intake price for scrap to 23¼ cents a pound. Otherwise, the price structure is unchanged with 30 cents a pound being applicable to both custom smelters and producers.

Tin has also suffered from end-of-year influences and the feeling is that consumers were content to wait until the New Year before entering the market. Just before Christmas, offerings of metal on the Singapore market were particularly heavy which depressed the Eastern price and this had its adverse effect in London with the result that the tin market faces the New Year with the price below £790 a ton. However, opinion still inclines favourably towards the outlook for this metal and it may well be that the price will soon be back up over the £800 a ton mark. In the US the market is as quiet as is the steel industry and the NewYork spot quotation is below $1.01 a pound.

Lead continues dull with the market in London still worried about the surplus supply position. This was made even worse last week by the registration of Russian lead on the London Metal Exchange. This week saw the beginning of a new trading regime for both lead and zinc which will now operate on the LME under a new contract which will involve daily settlement rather than a fortnightly settlement. In the US the market is quiet with the price called 11 cents a pound.

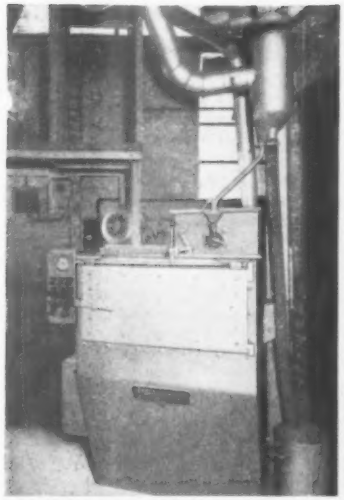
Zinc is also quiet and the price is down around its lowest for 18 months. However, there are some signs of an improvement but these are not to be mistaken for the beginning of a new trend. In the US the market is without feature and the East St. Louis spot price is still 12 cents a pound.

Manganese Bronze and Brass Reorganization

Reorganization, with effect from January 2, to integrate production facilities and co-ordinate sales of two subsidiaries has been undertaken by the Manganese Bronze & Brass Company, Limited, London, whose interests range from the manufacture of ships' propellers, brass and aluminium founding to high-precision machine manufacture and general engineering. As a result the firm's two subsidiaries (Dean & Son (Yorkshire), Limited, of Beverley, and Lightalloys, Limited, of Willesden, London) will lose their separate identities and become a division of the parent company, and a central sales office has been established at 10-12, Cork Street, London.

Export sales of ships' propellers will continue to be handled by Stone Manganese Marine, Limited, and the existing "Oilite" and wrought metal sales from the Ipswich works of the Manganese Bronze & Brass Company, Limited, will be unaffected. The two subsidiaries went into voluntary liquidation on January 2, emerging as the Deans & Lightalloys Division of the Manganese Bronze & Brass Company, Limited. At the same time, all production facilities for the new division will be housed in a large modern foundry in Beverley, Yorkshire, which it is claimed will be the largest aluminium foundry in the North of England. The Lightalloy factory at Willesden will be closed down.

DURING THE DISCUSSION on a paper covering accident prevention in the foundry industry, the author, Mr. M. Bourdon, suggested that the men from the shop floor, and not someone from the office, shou'd be charged with the duty of displaying and changing safety-first posters.



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HISTORICAL NOTE

Southend Engineering Company was established in 1901, and manufactured Marine and Stationary engines until 1914. The Firm has produced its own non-ferrous castings since 1938. They manufacture the "Viking 3" Outboard Motor, a set of flame guns for agricultural purposes, and a range of Stern Gear and fittings for marine engine manufacturers.

BP F10 7

Current Prices of Iron, Steel, and Non-ferrous Metals

(Basis prices, delivered unless otherwise stated)

January 4, 1961

PIG-IRON

Foundry Iron.—No. 3 IRON, CLASS 2, 10-ton lots or over: Middlesbrough, £21 17s. 0d.; Birmingham, £21 9s. 3d.

Low-phosphorus Iron.—Over 0.10 to 0.40 per cent. P 10-ton lots or over, £23 5s. 0d., delivered Birmingham, £23 10s. 0d., delivered Grangemouth.

Cylinder and Refined Irons.—North Zone, £25 6s. 6d.; South Zone, £25 9s. 0d.

Refined Malleable.—P, 0.10 per cent. max.; North Zone, £26 6s. 6d.; South Zone, £26 9s. 0d.

Hematite.—Si less than 2 per cent, S. & P. over 0.03 to 0.05 per cent., 10-ton lots or over; N.-E. of England (local iron), £23 19s. 0d.; Scotland (Scotch iron), Zone S.1, £24 5s. 6d.; Sheffield, £25 9s. 0d.; Birmingham, £25 13s. 0d.; Wales (Welsh iron), £23 19s. 0d.

Basic Pig-Iron.—£20 3s. 0d., delivered Staffs, Derbyshire, Notts, Lincs, Rutland, Northants, and Leicestershire in 10-ton lots or over.

FERRO-ALLOYS

(per ton unless otherwise stated, delivered)

Ferro-Silicon (6-ton lots and over).—45 per cent. Si, £43 10s. 0d. to £46 0s. 0d., scale 15s. 0d. per unit, lumpy. 75 per cent. Si, £60 0s. 0d. to £63 10s. 0d., scale 15s. 0d. per unit, lumpy.

Ferro-vanadium.—50/60 per cent., 22s. 6d. per lb. of V.

Ferro-molybdenum.—65/70 per cent., carbon-free, 12s. 10d per lb. of Mo.

Ferro-titanium.—20/25 per cent., 2-3 per cent. Cu, £250 0s. 0d.; 38/40 per cent., commercially carbon-free, £287 0s. 0d.

Ferro-tungsten.—80/85 per cent., 11s. 8d. per lb. of W.

Tungsten Metal Powder.—98/99 per cent., 14s. 8d. per lb. of W.

Ferro-chrome (6-ton lots and over, lumpy).—4/6 per cent. C, £81 10s. 0d. to £84 10s. 0d., basis 60 per cent. Cr scale 27s. 0d. to 28s. 6d. per unit; over 6 per cent. C, £79 0s. 0d. to £82 10s. 0d., basis 60 per cent. Cr, scale, 27s. 0d. to 28s. 6d. per unit; 2 per cent. C,* 1s. 8d. to 1s. 11d. per lb. Cr; 1 per cent. C,* 1s. 8d. to 1s. 11½d. per lb. Cr; 0.15 per cent. C,* 1s. 9½d. to 2s. 0½d. per lb. Cr; 0.10 per cent. C,* 1s. 9½d. to 2s. 0½d. per lb. Cr; 0.06 per cent. C,* 1s. 11d. to 2s. 1d. per lb. Cr.

Metallic Chromium.—98/99 per cent., 6s. 10d. per lb.

Metallic Manganese.—94/96 per cent., carbon-free, £275 0s. 0d.; 96/98 per cent., £285 0s. 0d.

Ferro-columbium.—65/67 per cent., Cb + Ta, 19s. 9d. per lb., Cb + Ta.

Ferro-manganese (Standard).—78 per cent., £61 10s. 0d.

SEMI-FINISHED STEEL

Re-rolling Billets, Blooms, and Slabs.—BASIC: Soft u.t., 100 tons & over, £31 15s. 6d.; tested, 0.08 to 0.33 per cent. C, 100 tons & over, £32 5s. 6d.; hard (0.41 to 0.60 per cent. C), 50 tons and over, £33 17s. 0d.; silico-manganese, 50 tons and over, £42 16s. 6d.; free-cutting, 50 tons and over, £35 4s. 6d. SIEMENS MARTIN ACID (50 tons and over): Up to 0.25 per cent. C, £40 11s. 0d.; silico-manganese, £43 4s. 0d.

Billets, Blooms, and Slabs for Forging and for Stamping (50 tons and over).—BASIC: Soft, up to 0.33 per cent. C, £37 0s. 0d.; basic, hard, over 0.41 up to 0.60 per cent. C, £38 2s. 6d.; acid, up to 0.25 per cent. C, £41 14s. 0d.

* Average 68-70 per cent.

FINISHED STEEL

Heavy Plates and Sections (50 tons and over).—Ship plate (N.-E. Coast), £40 7s. 0d.; boiler plates (N.-E. Coast), £42 17s. 0d.; floor plates (N.-E. Coast), £41 16s. 0d.; angles (N.-E. Coast), £38 1s. 6d.; joists (N.-E. Coast), £37 17s. 6d.

Small Bars, Sheets, etc.—Rounds and squares, under 3 in., and flats 5 in. wide and under, untested soft basic, 50 tons and over, £39 1s. 0d.; under 10 tons to 4 tons, £40 18s. 6d.; under 4 tons to 2 tons, £41 3s. 6d.; hoop and strip, coils, 100 tons and over, £38 0s. 0d.; uncoated strip mill coils, hot rolled, under 3 mm. to 12g., 25 tons to under 50 tons, £43 16s. 0d.; black sheets (hand mill), 24g., 10 tons and over, £57 14s. 6d.; galvanized corrugated sheets, 24g., 10 tons and over, £68 5s. 0d.

Alloy Steel Bars.—1 in. dia. and up: Nickel, £66 7s. 0d.; nickel-chrome, £97 1s. 0d.; nickel-chrome-molybdenum, £109 14s. 0d., in lots of 25 tons and over.

NON-FERROUS METALS

Copper.—Cash, £224 10s. 0d. to £224 15s. 0d.; three months, £224 5s. 0d. to £224 10s. 0d.; settlement, £224 15s. 0d.

Copper, Tubes, etc.—Solid-drawn tubes, 2s. 2⅛d. per lb.; rods, 246s. 6d. per cwt. basis; 20 s.w.g., 281s. 6d. per cwt.

Tin.—Cash, £788 0s. 0d. to £788 10s. 0d.; three months, £788 10s. 0d. to £789 0s. 0d.; settlement, £788 10s. 0d.

Lead (Refined Pig).—First half January, £62 15s. 0d. to £63 0s. 0d.; first half April, £63 15s. 0d. to £64 0s. 0d.; settlement, £63 0s. 0d.

Zinc.—First half January, £80 5s. 0d. to £80 10s. 0d.; first half April, £78 10s. 0d. to £78 12s. 6d.; settlement £80 10s. 0d.

Zinc Sheets, etc.—Sheets, 15g., and thicker, all English destinations, £114 7s. 6d.; rolled zinc (boiler **plates**), all English destinations, £112 2s. 6d.; zinc **oxide** (**Red** Seal) d/d buyers' premises, £95 0s. 0d.

Brass Tubes, etc.—Solid-drawn tubes, 1s. 10d. per lb.; sheets to 10 w.g., 197s. 9d. per cwt.; wire, 2s. 8¾d.; rolled metal, 197s. 9d. per cwt.

Brass (Brazing).—BS1400, B3, £174; B6, £225.

Brass (High Tensile).—BS1400, HTB1, £195; HTB2 £214; HTB3, £231.

Gunmetal.—BS1400, LG2, £216; LG3, £226; G1, ½%, £290; G1, 1%, £280.

Phosphor Bronze.—BS1400, PB1 (AID released), £306; BS1400, 90/10/1, £294.

Leaded Phosphor Bronze.—BS1400, LPB1, £237.

Phosphor Bronze Strip, etc.—Strip, 289s. 9d. per cwt.; wire, 4s. 0¾d. per lb.; rods, 3s. 3¾d.; tubes, 3s. 3¾d.; chill cast bars, solids 3s. 3½d.; cored 3s. 4½d. (CHARLES CLIFFORD LIMITED).

Nickel Silver, etc.—Rolled metal, 3 in. to 9 in. wide × 0.056, 3s. 11d. per lb.; round wire, 10g. in coils (10 per cent.), 4s. 4d.; special quality turning rod, 10 per cent., ½ in. dia., in straight lengths, 4s. 3d. All prices are net.

Other Metals.—Magnesium, ingots, 2s. 2½d. to 2s. 3d. per lb.; Antimony, English, 99 per cent., £200 0s. 0d. Quicksilver, ex-warehouse, £69 to £69 10s. 0d. Nickel, £600 0s. 0d. Aluminium, ingots, £186 0s. 0d.; aluminium bronze (BS1400), AB1, £243; AB2, £250.

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Pig-iron and Steel Production

Statistical Summary of Returns October, 1960

The following particulars of pig-iron and steel produced in Great Britain are from statistics issued by the British Iron and Steel Federation. Table 1 summarizes activities during recent months. Table 2 gives production of steel ingots and castings in October. Table 3, weekly average production of finished steel in September. Table 4 gives the production of pig-iron and ferro-alloys in October, and furnaces in blast. (All figures are weekly averages in thousands of tons).

TABLE 1.—*Iron and Steel Index and General Summary of Pig-iron and Steel Production.*

Period.	B.o.T. Price Index, 1938 = 100			Iron-ore output.	Imported ore used.	Coke sent to blast furnaces.	Pig-iron, ferro-alloys prod.	Scrap used in steel prod.	Steel (incl. alloy).			
	Iron and steel.	Coal.	Basic materials[1]						Imports.[2]	Prod. ingots, castings.	Delivrs. finished steel.	Stocks.[3]
1958	343	503	478	276	262	227	245	196	9	389	284	2,242
1959	340	497	477	286	244	210	242	208	7	388	291	2,244
1960—July ..	339	483	482	302	305	261	289	194	41	391	317	2,428
Aug.[4]	339	483	476	321	296	255	291	214	32	423	310	2,619
Sept.	339	520	473	336	317	265	306	252	25	481	391	2,644
Oct. ..	339	520	472	344	332	273	314	256	17	497	386	2,621

TABLE 2.—*Average Weekly Production of Steel Ingots and Castings in October.*

District.	Open-hearth.		Bessemer.	Electric.	All other.	Total.		Total ingots and castings.
	Acid.	Basic.				Ingots.	Castings.	
Derbys., Leics., Notts., Northants, and Essex ..	—	4.9	16.0 (basic)	2.6	0.1	22.0	1.6	23.6
Lancs. (excl. N.-W. Coast), Denbighs., Flints., and Ches.	1.5	40.1	—	5.7	0.3	46.2	1.4	46.2
Yorkshire (excl. N.-E. Coast and Sheffield) ..								1.4
Lincolnshire	—	52.1	—	—	0.1	52.0	0.2	52.2
North-East Coast	0.7	96.7	—	1.8	0.4	97.5	2.1	99.6
Scotland	0.5	49.6	—	3.0	—	50.9	2.2	53.1
Staffs., Shrops., Worcs., and Warwicks ..	—	27.8	—	4.6	0.8	31.2	2.0	33.2
South Wales and Monmouthshire	1.9	95.0	17.1 (basic)	0.9	0.2	114.6	0.5	115.1
Sheffield (incl. small tonnage in Manchester) ..	9.0	41.0	—	15.2	0.4	63.5	2.1	65.6
North-West Coast	0.1	—	6.0 (acid)	0.9	—	6.8	0.2	7.0
Total	13.7	407.2	39.1	34.7	2.3	484.7	12.3	497.0
September, 1960	12.6	394.8	37.1	34.2	2.3	469.0	12.0	481.0
October, 1959	14.3	362.3	30.7	32.0	2.1	430.7	10.7	441.4

TABLE 3.—*Deliveries of New Non-alloy and Alloy Finished Steel.*

Product.	1958.	1959.	1959.	1960.	
			Sept.[5]	August.[5]	Sept.
Non-alloy steel:					
Ingots, blooms, billets, and slabs[6]	4.6	5.1	5.7	4.2	6.6
Heavy rails ..	10.2	6.8	6.8	8.2	8.6
Sleepers	1.2	0.6	0.5	0.6	2.0
Fishplates and soleplates ..	0.7	0.4	0.4	0.5	0.7
Plates, 3 mm. thick and over:	47.3	43.1	45.6	48.2	56.9
Other heavy prods.	41.8	41.2	48.0	42.0	56.1
Ferro-concrete bars	7.6	9.6	12.9	9.0	14.3
Wire rods	21.5	23.5	24.7	23.5	29.8
Arches, etc. ..	8.6	7.8	7.8	6.6	8.3
Other light sections	29.1	33.0	36.9	31.6	43.7
Bright steel bars ..	6.2	7.6	8.3	7.6	10.6
Hot-rolled strip ..	22.6	27.4	30.1	23.6	36.3
Cold-rolled strip ..	7.0	8.0	9.2	7.6	11.6
Sheets, coated:	41.7	47.0	51.6	52.1	54.5
Tinplate	18.7	20.9	23.7	17.4	23.8
Blackplate ..	0.8	0.7	0.9	0.7	1.1
Tubes up to 16 in. ..	19.0	20.6	22.5	17.5	27.7
Tube fittings, etc. ..	0.4	0.4	0.4	0.3	0.5
Tyres, wheels, and axles	4.5	2.4	1.8	2.2	2.2
Forgings (excl. drop)	2.6	2.1	2.0	1.8	2.5
Steel castings ..	4.2	3.6	3.7	3.7	4.6
Tool steel	0.2	0.2	0.2	0.2	0.3
Total	300.5	312.0	343.7	308.9	402.7
Alloy steel	16.1	18.2	18.5	17.1	25.0
Total deliveries from UK prod.[6] ..	316.6	330.2	362.2	326.0	427.7
Add: Imported finished steel ..	7.0	7.1	6.1	24.2	21.6
	323.6	337.3	368.3	350.2	449.3
Deduct: Intra-industry conversion[7] ..	41.2	47.6	51.7	41.0	59.6
Total new material ..	282.4	289.7	316.6	309.2	389.7

TABLE 4.—*Production of Pig-iron and Ferro-alloys.*

District.	Fur. naces in blast.	Hema-tite.	Basic.	Foun-dry.	Forge.	Ferro-alloys.	Total.
Derbys, Leics, Notts, Northants, and Essex	20	—	30.5	20.2	0.1	—	50.8
Lancs (excl. N.-W. Coast), Denbighs, Flints, and Ches. ..	7	—	24.6	—	—	1.9	26.5
Yorkshire (excl. N.-E. Coast and Sheffield) ..	—	—	—	—	—	—	—
Lincolnshire ..	10	—	45.1	—	—	—	45.1
North-East Coast	18	2.3	67.3	—	—	1.3	70.9
Scotland	7	1.6	23.6	1.1	—	—	26.3
Staffs, Shrops, Worcs, and Warwicks ..	5	—	10.9	1.0	—	—	11.9
S. Wales and Monmouthshire	10	2.3	53.6	1.3	—	—	57.2
Sheffield	2	—	3.4	—	—	—	3.4
North-West Coast	8	19.1	—	1.6	—	1.1	21.8
Total ..	87	25.3	259.0	25.2	0.1	4.3	313.9
September, 1960..	87	21.5	256.4	23.2	0.1	4.6	305.8
October, 1959 ..	76	22.0	220.0	23.9	1.1	2.8	269.8

[1] Used in non-food manufacturing industries.
[2] Weekly average of calendar month.
[3] Stocks, mainly ingots and semi-finished, at the end of the year and months shown.
[4] Five weeks, all tables.
[5] Other than for conversion into any other form of finished steel listed.
[6] Includes finished steel produced in the UK from imported ingots and semi-finished steel.
[7] Material for conversion into other products also listed in this table.

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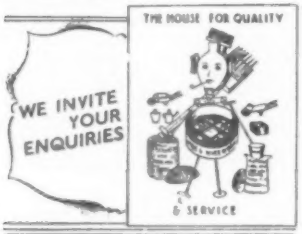

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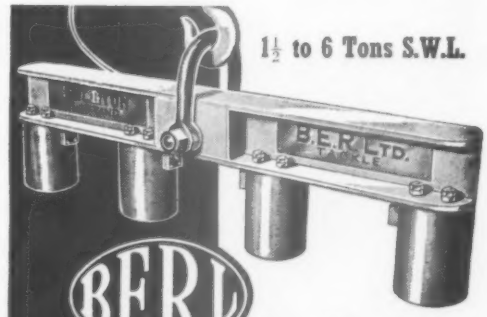

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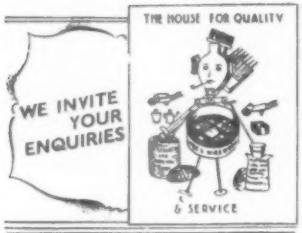

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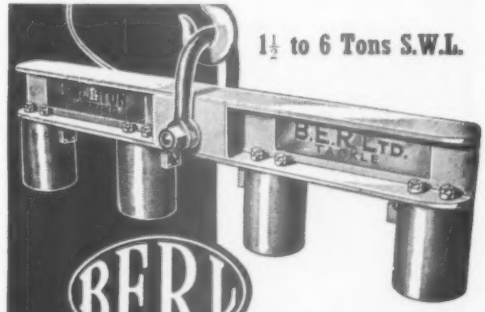

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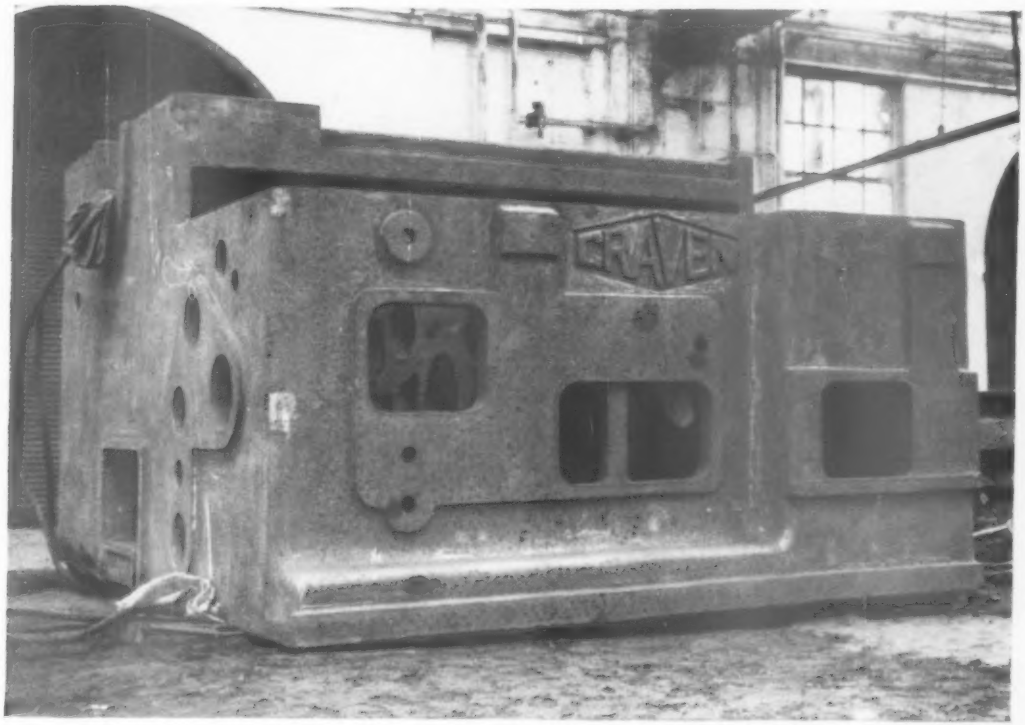

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VOL. 110
No. 2300
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JANUARY 5, 1961
Offices: John Adam House, John Adam St., London, W.C.2

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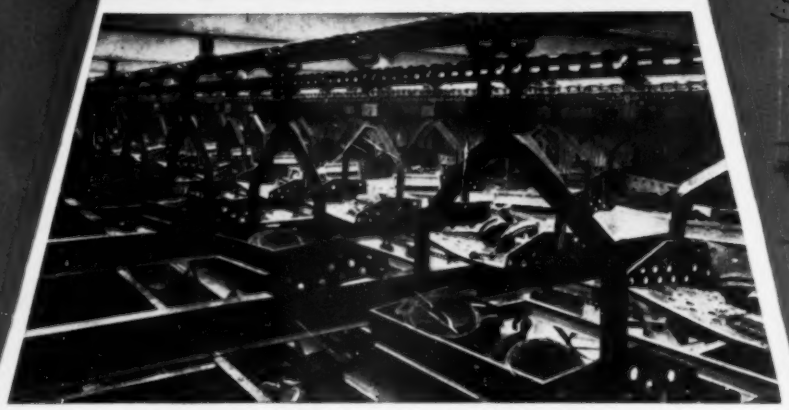

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